

INSTRUCTION BOOK

VOLUME II

Engine type
H21/32

Hyundai Heavy Industries Co., Ltd.
Engine & Machinery Division
1, Cheonha-Dong, Dong-Gu, Ulsan, Korea
<http://www.hhi.co.kr>
<http://as.hyundai-engine.com>

Engine After-sales Service Dept.

Warranty Service

TEL : (82) 52-202-7412~20

FAX : (82) 52-202-7581

(82) 52-250-9841

E-mail : engineas@hhi.co.kr

Parts Sales

TEL : (82) 52-202-7311~20

FAX : (82) 52-202-7582

E-mail : eservice@hhi.co.kr

**This book must in no case be wholly or partially copied and published
or passed to unauthorized persons without the permission of HYUN-
DAI HEAVY INDUSTRIES CO., LTD. ENGINE & MACHINERY DIVISION.**

Operation Manual

TPS48-61D/E/F

		ABB Turbo Systems Ltd CH 5401 Baden		
Type	TPS48-61D/E/F	HT		
n_{Mmax}	1/s	t_{Mmax}	°C	
n_{Bmax}		t_{Bmax}		
	kg			
Year	2005	Application according to the Operation Manual		
made in Switzerland				

HZTL2410 English

Operating condition and replacement intervals

The operational limits for the turbocharger n_{Bmax} , t_{Bmax} , n_{Mmax} , t_{Mmax} , inspection- and replacement intervals for the components concerned on the rating plate are valid for the operational mode and compressor inlet condition, which has been agreed upon between the engine builder and ABB.



Note: Replacement intervals of components depends on the load profile, turbine inlet temperature, suction air temperature and turbocharger speed. In case the operation conditions differs significantly from what is considered to be normal for the current application, it is recommended to contact ABB for a re-calculation of replacement intervals. Frequent load alterations, high temperatures and high speed lower the life of components.
Unless otherwise agreed, the application limits n_{Mmax} , t_{Mmax} are valid for the test operation for a limited time.

We herewith confirm that this Operation Manual has been drawn up orientated towards the Product Liability Law 1/1/90 as well as to the „European Machinery Directives“.

We reserve all rights in this document and in the information contained herein.
Reproduction, use or disclosure to third parties without express authority by ABB Turbo Systems Ltd is strictly forbidden.

© Copyright by ABB TURBO SYSTEMS Ltd 2004

Design and specifications are subject to change without notice.

Printed on naturally white paper, bleached free from chlorine and environmentally acceptable.

The CD is made of polycarbonate and contains in addition aluminium, lacquer, dye stuffs and materials of the adhesive label. The CD-cover is made of recycled cardboard.

These materials may be disposed with the domestic wastes or at a specialised collecting centre.



ABB Turbo Systems AG
Bruggerstrasse 71a
CH-5401 Baden
Switzerland

Table of Contents

1	Preliminary remarks
1.1	Foreword
1.2	Layout and function
1.3	Correct application
1.4	Essential information
1.5	Abbreviations and symbols
1.6	Turbocharger rating plate
2	Safety
2.1	Basic safety instructions
2.2	General safety instructions
2.3	Special safety instructions
2.4	Safety instructions and hazard protection
3	Commissioning
3.1	Oil supply
3.2	Inspection work
3.3	Putting into operation after out of service period
4	Operation
4.1	Servicing work
4.2	Monitoring
4.3	Surging of turbocharger
4.4	Contact with rotating parts
4.5	Shutting the engine down
5	Maintenance
5.1	Outline of cleaning work
5.2	Cleaning the filter silencer
5.3	Cleaning the compressor during operation
5.4	Cleaning turbine blades and nozzle ring in operation
5.5	Maintenance work

6	Troubleshooting
6.1	Possible remedies for failures
7	Removal and installation
7.1	Turbocharger weights
7.2	Remove the turbocharger
7.3	Installing the turbocharger
8	Disassembly and assembly
8.1	Module weights
8.2	Disassembling and assembling turbocharger (with V-band connection)
8.3	Disassembling and assembling turbocharger (with strap connection)
8.4	Axial and radial clearances
8.5	Table of tightening torques
9	Taking out of operation
9.1	Turbocharger shut down (with V-band connection)
9.2	Turbocharger shut down (with strap connection)
10	Mothballing the turbocharger
10.1	Taking out of operation for up to 12 months
10.2	Taking out of operation for more than 12 months
11	Reserve and spare parts
11.1	Ordering spare parts
11.2	Directory of part numbers
11.3	General view of turbocharger
11.4	General view of cartridge group

1 Preliminary remarks

1.1 Foreword

This operation manual will help you to become familiar with your ABB Turbo Systems Ltd turbocharger and to use it to full effect in its intended application. You will find important instructions as to the safe, correct, and economical operation of the turbocharger.

This operation manual includes helpful information on the following topics:

- Information on the operation of a turbocharger and ways to prolong the turbocharger's service life.
- Early awareness and avoidance of hazards.
- Minimising repair costs and failure times.

This operation manual is a complement to, and an extension of, existing national regulations on accident protection and prevention.



NOTE

At least one operation manual must be available at all times at the site where the turbocharger is used. It is essential that this operation manual is read before beginning work by all persons working with or on the turbocharger. Personnel only working occasionally on the turbocharger (e.g. during installation and maintenance) must also have read and fully understood the operating manual before working on the turbocharger.

The instructions included in this operation manual must be followed under all circumstances.

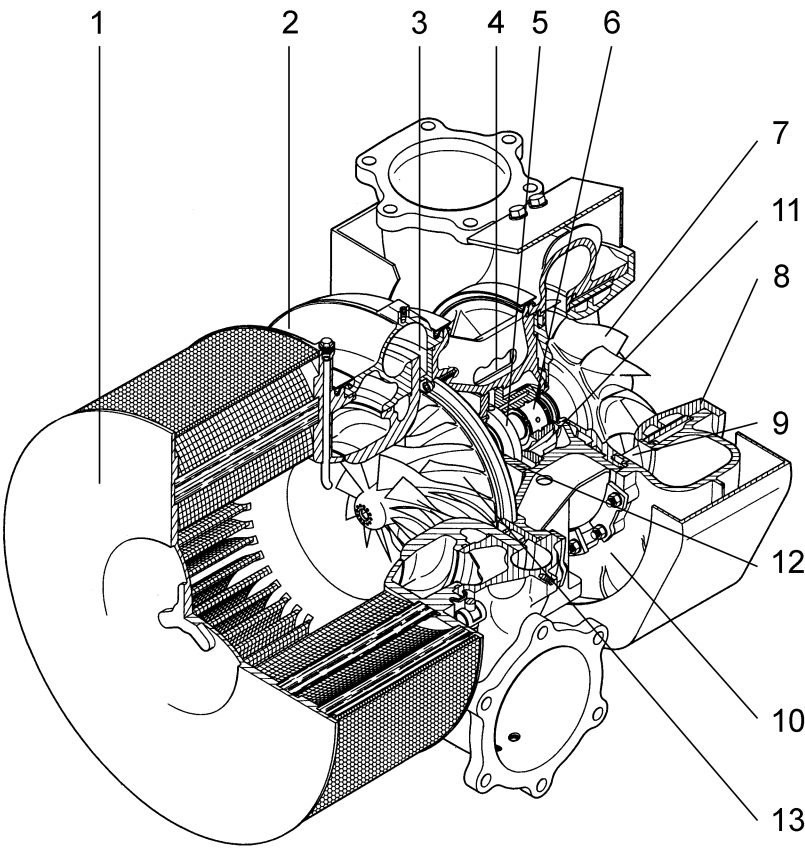


NOTE

This applies especially to the general and special safety instructions preceding and in the respective chapters. Ignoring hazards and the safety instructions can lead to serious personal injury and damage to equipment.

In the event of doubt, consult the officer for safety and accident protection responsible for your area.

1.2 Layout and function



S_00095

1	Suction branch / Filter silencer	8	Gas outlet flange
2	Compressor casing	9	Nozzle ring
3	Diffuser	10	Turbine casing
4	Bearing casing	11	Turbine-end bearing flange
5	Axial thrust bearing	12	Compressor-end bearing flange
6	Radial plain bearing (only visible turbine-end)	13	Compressor wheel
7	Turbine		

September 2005

HZTL2410_EN (TPS48-61)

Version 2

Preliminary remarks	1	
Layout and function	1.2	Page 3

Mode of operation

The turbocharger is a turbo-machine and consists of the following main components:

- Turbine
- Compressor

These are both connected with a common shaft.

The exhaust gases from the diesel or gas engine flow through the turbine casing (10) and nozzle ring (9) to the turbine (7).

The turbine (7) uses the energy contained in the exhaust gas to drive the compressor wheel (13), whereby the compressor draws in fresh air, and the compressed air is forced into the cylinders.

The exhaust gases escape through the exhaust pipe which is connected to the gas outlet flange (8).

The air which is necessary for the operation of the diesel or petrol engine and which is compressed in the turbocharger, is drawn through the suction branch or the filter silencer (1) into the compressor wheel (13). It then passes through the diffuser (3) and leaves the turbocharger through the outlet on the compressor casing (2).

The rotor runs in two radial plain bearings (6), which are located in the bearing flanges (11/12) between the compressor and the turbine. The axial thrust bearing (5) is located between the two radial plain bearings.

The bearings are connected to a central lubricating oil feed which is supplied by the oil lubrication circuit of the engine. The oil outlet is always at the lowest point of the bearing casing (4).

September 2005

HZTL2410_EN (TPS48-61)

Version 2

1.3 Correct application



NOTE

This turbocharger supplied by ABB Turbo Systems has been developed exclusively for use on diesel and gas engines to generate the volume of air and the charging pressure necessary for the operation of such engines. Any other usage shall be regarded as a special application which must be discussed with ABB Turbo Systems. The manufacturer accepts no liability for other applications.

The turbocharger has been designed for the diesel or petrol engine described, including speed and output. If it is used otherwise ABB Turbo Systems reserves the right to reject all claims under the warranty.

This turbocharger was built in accordance with state of the art technology and is operationally safe according to prevailing safety regulations.



NOTE

The turbocharger may be hazardous to life and limb of the user or third parties. In addition, improper use may cause damage to the machine.

The machine may only be operated by trained personnel.

Correct use of the turbocharger also includes observation of the assembly, disassembly, operating, maintenance and repair conditions specified by the manufacturer. Regulations set out by local authorities must be observed when disposing of the turbine.

The turbocharger should only be operated and used in a technically perfect condition, for its intended purpose and in compliance with the operation manual.

► Defects which could affect safety must be eliminated immediately.

The manufacturer shall not accept liability for damages resulting from unauthorised alterations to the turbocharger.

1.4 Essential information

Organizational measures

In addition to this manual, the general, statutory regulations applicable in the respective country for the prevention of accidents and the protection of the environment must be observed.

This also applies to the provision and wearing of personnel protection equipment.



NOTE

The safety and risk consciousness of the personnel working on and with the turbocharger must be checked regularly with reference to this manual.

- The turbocharger must be shut down immediately in the event of alterations affecting safety or of corresponding operating behaviour. The fault should be reported to the person or department responsible.



NOTE

Additions to, and alterations and conversions of the turbocharger that could compromise safety require the prior approval of ABB Turbo Systems.

Original parts and safety

Original parts and accessories are especially designed for the turbocharger supplied by ABB Turbo Systems Ltd .



NOTE

We herewith expressly state that parts and accessories not supplied by us have also not been tested and approved by us.



WARNING

If components and assemblies not manufactured and tested by ABB Turbo Systems are used, this may have a negative effect on the technical design specifications of the turbocharger.

Moreover, the active and/or passive safety of the turbocharger may be compromised by the use of non-original parts. Note that such improper use may endanger personnel and the machine.

ABB Turbo Systems shall not be liable for any damage caused by using non-original parts and accessories.

Qualification of personnel

The turbocharger must only be operated and maintained by trained and authorised personnel.



CAUTION

Work on mechanical components, such as bearings or rotors, must only be performed by qualified fitters from an official service station of ABB Turbo Systems Ltd !

It must be ensured that only authorised personnel work on the turbocharger.

Preliminary remarks	1	
Essential information	1.4	Page 7

After-sales service

The Contact Information brochure contains an overview of official ABB Turbo Systems Ltd service stations worldwide.

Design variants

This instruction manual is valid for various turbocharger design variants.

This means that some sections and component descriptions in this operating manual do not apply to your turbocharger.

Our service stations and agencies will gladly answer your questions relating specifically to your model.

Storage of new turbochargers

New turbochargers supplied by ABB Turbo Systems Ltd can be stored without additional safeguarding measures for a period of 6 months after the delivery date.

Ensure that the area where the turbocharger is to be stored is dry with humidity of 40-70% and free of condensation.

- ▶ After 6 months, rust-proofing oil should be sprayed on exposed surfaces and all accessible areas of the turbocharger.
- ▶ To do this, the insulating materials must be removed.



NOTE

Repeat the steps described for rust-proofing your turbocharger every 6 months.

1.5 Abbreviations and symbols

The following abbreviations are used in this document:

▷ Prerequisite

► Work step

⇒ Result

✓ Positive checkpoint (activity which must be performed without fail)

✗ Negative Checkpoint (activity which may not be performed under any circumstances)

1.6 Turbocharger rating plate

		ABB Turbo Systems Ltd CH 5401 Baden	
Type		HT	
n _{Mmax} _____	1 s	t _{Mmax} _____	°C
n _{Bmax} _____	kg	t _{Bmax} _____	°C
Year _____	Application according to the Operation Manual		
made in Switzerland			

L_00012

Operational limits

- 1 Turbocharger operational limits at engine overload (110%).
In test rig operation only, unless otherwise agreed with the engine manufacturer.
- 2 Turbocharger operational limits in service.

Inspection and exchange intervals for turbocharger components

- 3 Inspection interval for plain bearings in 1000 h
- 4 Exchange interval for the compressor in 1000 h (no values 100,000 h)
- 5 Exchange interval for the turbine in 1000 h (no values 100,000 h)

Preliminary remarks	1	
Turbocharger rating plate	1.6	Page 10

September 2005

HZTL2410_EN (TPS48-61)

Version 2

- Additional specifications:
- 6

Customer part number
- 7

Field for special design designation
- 8

Weight of the turbocharger in kg
- 9

CE = Conformité Européenne
- 10

Turbocharger type
- 11

Series number
- 12

Year of construction of the turbucharger

Explanations of the rating plate

The conditions agreed with the engine manufacturer apply to the values indicated on the rating plate with regard to operational limits, inspection intervals and replacement intervals.



Continuous running above the indicated values n_{Bmax} , t_{Bmax} can considerably reduce the recommended exchange intervals. In such cases, you should contact the nearest official service station of ABB Turbo Systems Ltd.

n_{Mmax} , t_{Mmax} normally apply only when running at overload (110%) during trials on the engine test bed. These limits may also be permitted in service for special applications. The operation over n_{Mmax} , t_{Mmax} is not permitted.

Non-compliance with the recommended exchange intervals may increase the risk of unpredictable component failure.

The inspection intervals and replacement intervals for the turbocharger components specified must be observed without fail!

Turbocharger components whose permissible operating times have expired may not be used again under any circumstances!

2 Safety

2.1 Basic safety instructions

The following symbols and terms are used for the safety instructions in this operation manual:



WARNING

Serious injury or fatal accident may result if the working and operation instructions marked with this symbol are not, or only partly observed.

Warning signs must be strictly observed at all times.



CAUTION

Serious damage to the machine or to other property may result if the working and operation instructions marked with this symbol are not, or only partly, observed.

Caution signs must be strictly observed at all times.

2.2 General safety instructions

The instructions listed here are designed to ensure your safety and to promote safe handling of the turbocharger and its associated operating materials.



WARNING

The following safety instructions must be followed when operating and when working on the turbocharger.

- Do not work on the turbocharger if you are under physical or mental stress.
- Wear protective clothing at all times.
 - Helmet
 - Ear protection
 - Protective glasses
 - Protective suit
 - Oil and petrol resistant gloves
 - Protective shoes
- Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.
- Do not stand under suspended loads.
- If welding work is to be carried out above the turbocharger, the air filter must be covered to prevent damage to the filter mat.
- When working on the turbocharger, be aware of the risk of it falling.
- For overhead assembly work, use the steps and platforms provided for this purpose.

2.3 Special safety instructions

Safety when connecting

- Work only on those connections for which you are qualified.

Safety when commissioning and during operation

- Before starting work, make a visual inspection of the working area.
- Remove obstacles and any objects lying around from the work area.
- Before commissioning check the turbocharger for damage and leaks.
- Refrain from any activity which could compromise safety while working with the turbocharger.
- Inspect the turbocharger after about 12 hours of operation or at least once a day for visible damage and defects.
- Report any damage or changes in operational performance to the person/department responsible immediately.
- In the event of damage, shut down the turbocharger immediately and secure it against inadvertent or unauthorized use.

Safety when cleaning

When handling detergents, solvents, acids and alkalis be sure to observe the respective safety directions on the manufacturers' labels.

Follow directions regarding the environmentally compatible collection, storage and disposal of these liquids.



WARNING

Explosion hazard

Cleaning work should be carried out outdoors due to explosion hazard. If this is not possible, ensure that there is adequate ventilation and air circulation. Before beginning cleaning work in confined spaces, extinguish naked flames (including cigarettes!) due to the risk of explosion.

- Before cleaning, protect the floor against unintended leaks of oil and operation materials.
- You must wear protective clothing (see section **General safety instructions**).
- Handle operation materials and detergents with utmost caution.
- When handling solvents, wear protective clothing **and** observe the following rules:
 - Avoid skin contact with solvents.
 - Avoid inhaling vapours under all circumstances.
 - Do not allow solvents to soak protective clothing.
- After cleaning, check electric cables for signs of wear or damage.

Safety during disassembly, assembly, maintenance and troubleshooting

- Perform the prescribed adjustment, maintenance and inspection work at the specified intervals.
- Inform operating personnel about special work and repairs before starting.
- Ensure that absorbent materials are available to clean up any operation materials that escape accidentally.
- Ensure safe and environmentally-friendly drainage, collection and disposal of operating and auxiliary materials.
- Before opening a cover or removing a protective component on the turbocharger, the engine must have been switched off and must not be started up again until all parts have been properly re-assembled.

**CAUTION**

Assembly and disassembly work must only be performed by trained personnel. Work on mechanical components, such as bearings or rotors, must only be performed by qualified fitters from an official service station of ABB Turbo Systems.

Safety when taking out of operation or putting into storage

- Secure the rotor against turning.
- Clean the turbocharger before mothballing.
- Wear protective clothing when mothballing the turbocharger.
- Keep the work area clean and free of oil and operating materials.
- Remove any obstacles lying around on the floor.

2.4 Safety instructions and hazard protection

Associated hazards may arise during operation of and work on the turbo-charger:

- from the turbocharger and its accessories.
- from the operating materials used.
- due to failure to comply with the safety instructions.
- from inadequate performance of maintenance and inspection work.

Mechanical influences

Mechanical influences can cause serious or even fatal injury:

Personal injury

Unconsciousness and injury due to:

- crushing
- shearing
- cutting
- winding
- smashing
- drawing in
- knocking
- stabbing
- rubbing
- escape of liquids under high pressure **and** at high temperature
- slipping
- tripping
- falling

Causes

- sharp edges, pointed parts
- crush, shear and winding areas
- fragmentation / ejection of parts
- fracture or rupture of parts due to overload
- Elastic elements (springs), liquids **and** gases under pressure/in a vacuum
- slippery, oily work area, obstacles on the floor

Protective measures

- ✓ Wear leather protective gloves
- ✓ Wear close-fitting protective clothing
- ✓ Tie up long hair and beards (wear hair protection)
- ✓ Wear face and eye protection
- ✓ Wear protective shoes
- ✓ Keep floor, equipment and the turbocharger clean
- ✓ Ensure the availability of oil absorbing materials and have oil collector basins ready or in position
- ✓ Eliminate leaks

Operation and process materials

Operation and process materials refer to **chemical and hazardous substances**:

- Oil
- Grease
- Coolants
- Detergents and solvents
- Acids

**CAUTION**

Note that operation and process materials are harmful to the environment if they penetrate soil or water.

Personal injury

The following injuries can be caused by operation and process materials:

- Allergies
- Skin disease
- Loss of consciousness
- Poisoning or nausea after inhalation

Causes

- Inhalation of toxic gases, smoke and vapours
- Skin contact with aggressive fluids
- Clothing wet or soaked with hazardous substances
- Spilling and tipping over of vessels containing substances used during operation
- Escape due to leakage
- Tanks and collectors which are not gas-tight and which do not comply with the regulations on hazardous substances
- Burning cigarettes or open flame in the proximity of operation materials

Protective measures

- ✓ Utmost caution when handling process and operation materials
- ✓ Protective clothing must be worn
- ✓ Avoid skin contact and inhalation under all circumstances
- ✓ Ensure that the workroom is properly ventilated
- ✓ Observe the hazard indications on the containers for operation and process materials
- ✓ Immediately after use, seal the hazardous substance container tight
- ✓ Used operation materials must be collected safely in accordance with the legal provisions, stored separately in suitable containers as prescribed, and disposed of as special waste in a technically and environmentally compatible manner
- ✓ Ensure that containers for new / used operation materials are sealed tight
- ✓ In the event of leaks or spills immediately apply a suitable absorbent material and dispose of this in a technically and environmentally compatible manner as special waste

Handling insulating materials

- ✓ Ensure that the work area is well ventilated
- ✓ Keep the work area clean
- ✓ Avoid disturbing dust
- ✓ Dust-suppressing tools and processing steps
- ✓ Remove from packaging only in the work area
- ✓ Exercise particular care when removing old insulating materials
- ✓ Dispose of insulating materials in a technically and environmentally compatible manner
- ✓ If large quantities of dust are created, wear protective glasses
- ✓ Use half or quarter masks
- ✓ Wear suitable work clothing and gloves
- ✓ For sensitive skin, apply moisturising, protective barrier cream

September 2005

HZTL2410_EN (TPS48-61)

Version 2

Noise

The effects of noise above a legally permitted level can cause personal injury.

- Personal injury
 - Loss of hearing
 - Deafness
 - Impaired hearing
 - Health disorders such as loss of balance or of consciousness
 - Cardiac and circulatory disturbances
- Causes
 - Machine noise level above 85 dB (A)
- Protective measures
 - ✓ Wear ear protection

Heat hazard

When the turbocharger is operated, surfaces become very hot.

- Personal injury
 - Burns
- Causes
 - Missing or incorrectly fitted insulation.
- Protective measures
 - ✓ Wear leather protective gloves.

3 Commissioning

3.1 Oil supply

A carefully designed oil supply, which functions under all operating conditions, is an important precondition for trouble-free operation of the turbocharger.

Lubrication of the turbocharger is normally carried out with oil from the engine oil circuit.

If a separate lubrication system is used, then standby lubrication is also to be provided.



NOTE

The engine manufacturer's recommendations regarding oil selection and oil change intervals are to be observed.

Oil filtration



CAUTION

To prevent dangerous wear to the bearing parts, depending on the turbine specification and bearing used, different-sized impurities must be filtered out of the lubrication oil.

As standard, for the turbocharger an oil filtration of **34 µm** is prescribed. That means, impurities which are larger than **0.034 mm**, must be filtered out of the oil with a filtration efficiency of **> 99%**.

- ▶ If the oil is not sufficiently filtered through the engine filter, an additional filter is to be installed.
- ▶ During a cold start and, if due to deposits of dirt in the additional filter, the flow resistance rises above **0.5 bar**, a bypass must respond, which guarantees the oil supply of the turbocharger by bypassing the filter.
- ▶ Before putting into operation for the first time, check that the oil filters are clean.



NOTE

Also observe the specifications of the engine manufacturer concerning filter fineness and filtration efficiency.

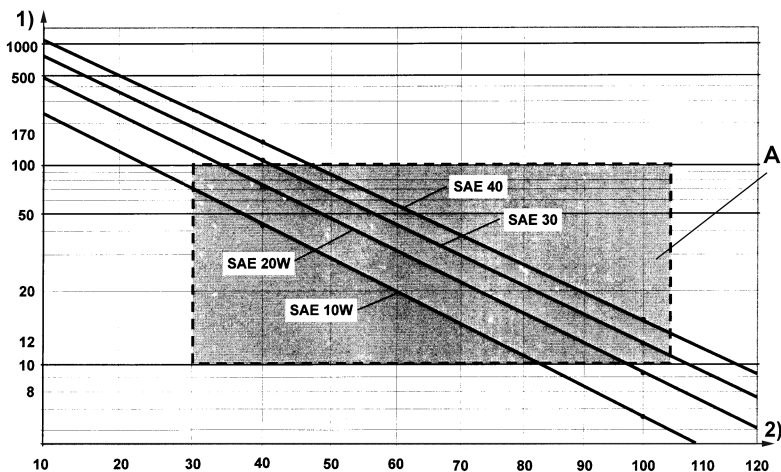
Lubricants



All lubricating oils used for engines are permissible.

Oil inlet viscosity and temperature

The oil inlet temperature must not exceed 105°C. The permissible oil inlet viscosities and temperatures are shown in the following diagram.



S_00132

1)	Kinetic viscosity (mm ² /s = cSt)
2)	Oil inlet temperature (°C)
A	Permissible range



During engine start, the lower temperature limit may be temporarily undershot.
The oil inlet temperature however should thereby not fall below 10 °C.

September 2005

HZTL2410_EN (TPS48-61)

Version 2

Oil pressure

The oil pressure before the bearings must be exactly maintained to ensure fault-free operation.

The oil pressure (overpressure) before the turbocharger with the engine under load should be **2.0 ... 4.5 bar** and at idling speed at least **0.2 bar** .

With cold oil, during the starting phase, temporarily a higher oil pressure of up to **8 bar** is permissible. During pre- and post-lubrication, the oil pressure must not exceed **1.0 bar** .

Pre-lubrication



Before every engine start, actuate pre-lubrication device. The turbocharger must be supplied with oil from the very first moment the engine is started.

3.2 Inspection work

This inspection work includes preventive visual controls, as well as monitoring and measurement to ensure the correct functioning of the turbo-charger. These serve as an aid to detecting anomalies before and during commissioning, thus preventing possible damage to the machine.

- The safety instructions must be followed before and during all inspection work.

3.2.1 Inspection before commissioning

- | | |
|-------------------------|---|
| Monitoring equipment | ► To be checked for correct functioning. |
| Oil filters | ► Check cleanliness before commissioning. |
| Manometers on oil lines | ► Check oil pressure in oil supply lines. |
| Air filter mat | ► Inspect for damage. |



CAUTION

It is urgently recommended that the entire lubrication system is bridged using a bypass pipe, in order to be flushed thoroughly with warm, clean oil before commissioning and after every servicing operation on the lubrication system.

We strongly recommend the use of a starting filter when running the engine in and after every servicing operation on the lubrication system.

Pre-lubrication



CAUTION

Before every engine start, actuate pre-lubrication device. The turbo-charger must be supplied with oil from the very first moment the engine is started.

3.2.2 Inspection after commissioning

- Charger speed** ▶ Measuring (optional, charger speed counter not included as standard with all turbocharger types)
- Charger pressure** ▶ Measuring
- Temperatures** ▶ Measure upstream/downstream from turbine, compressor and oil feed for various engine speeds
- Gas, air, and oil lines** ▶ After the engine has been started up, check all gas, air and oil lines for leaks.



NOTE

Lubricants and pastes used during assembly of the turbocharger are liquefied or vaporised and may escape as an oily liquid or smoke in the first few hours after commissioning. If oily liquid continues to escape after this period, the cause must be treated as an oil leak and located. The first step in this process is to check the oil supply to the turbocharger for leaks. If this is not in order, contact an official ABB Turbo Systems service station.

- ▶ Measure the speed, oil pressure, charging pressure and temperatures before and after the turbine and the compressor at various engine speeds.
- ▶ Compare the measured values with those of the inspection report, taking into account the different operating conditions.

3.2.3 Inspection after 100 service hours

Clean or replace lubricating oil filters after the first 100 service hours.

3.3 Putting into operation after out of service period

- ▶ Inspect the exhaust pipe before and after the turbine for possible combustion residues, foreign bodies or residual water and clean if necessary.
- ▶ Start up the engine end oil circulation system.
- ▶ Inspect air supply lines or filter segments for possible foreign bodies and clean if necessary.

4 Operation

4.1 Servicing work

Servicing work during operation includes visual checks, monitoring and measuring as well as inspection and function checks in order to ensure correct functioning of the turbocharger. It serves as an aid to detecting anomalies during operation, thus preventing damage to the machine. The inspection, measurement and servicing operations listed must be carried out at the intervals indicated.



WARNING

The pertinent safety instructions must be observed during all servicing work.



CAUTION

Servicing work must be carried out at the prescribed intervals in order to avoid damage to and malfunctioning of the turbocharger.

4.1.1 Servicing work every 25 to 50 hours

Operation data

- ▶ must be recorded
- ▶ Enter in the machine logbook
- ▶ In the event of significant anomalies, establish the cause



CAUTION

If you are unable to establish the cause of the anomalies, contact an official ABB Turbo Systems service station.

- ▶ Visual check for air, exhaust gas, water and oil leaks.

4.1.2 Servicing work according to the engine manufacturer's instructions

Oil filters

- ▶ With the engine at standstill clean or replace oil filters

4.1.3 Servicing work every 8,000 -12,000 hours

- ▶ Dismantle the turbocharger
- ▶ Clearance measurement
- ▶ Clean turbine- and compressor casings and check for any cracks and erosion / corrosion.
- ▶ Clean bearing casing, blow through oil ports
- ▶ Clean nozzle ring and check for cracks and erosion
- ▶ Inspection and assessment of the rotor and bearing parts



NOTE

Inspection and assessment of the rotor

The first inspection and assessment of the bearing parts has to be carried out in acc. with the rating plate or between 8,000 and 12,000 service hours.

The inspection and assessment of the rotor and the bearing parts must be carried out by an official service station of ABB Turbo Systems.

4.1.4 Entries in the machine logbook

Monitoring of the machine plant provides information about the performance of the turbocharger.

The following operation data and measurement values must be entered regularly in the engine manufacturer's machine log book:

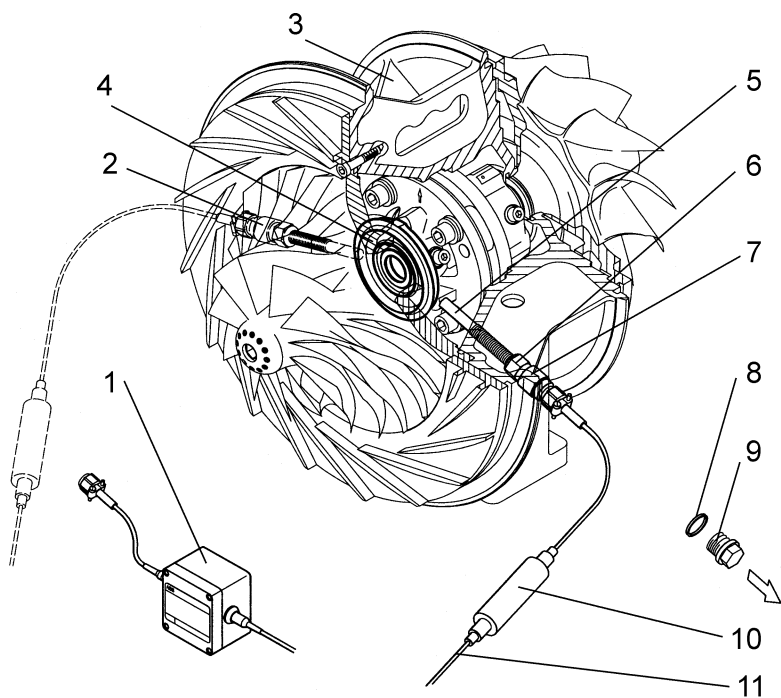
- Output and speed of the engine
- Air intake temperature
- Exhaust gas temperature before and after the turbine
- Pressure of the charge-air
- Pressure drop in the charge-air cooler
- Lube oil pressure, lube oil temperature

If provided

- Air temperature after compressor and after the charge-air cooler
- Speed of the turbocharger
- Pressure loss in the air filter

4.2 Monitoring

4.2.1 Speed measurement



S_00096

1	Line amplifier	7	Cable plug
2	Installation variants (right or left)	8	Gasket
3	Bearing casing	9	Screw plug
4	Sealing disc with cam or groove	10	Voltage limiting module
5	Speed transmitter	11	Connecting cable
6	Flange plug		

TPS turbochargers can be optionally fitted with a speed transmitter system for measuring the turbocharger speed. This speed transmitter, in connection with the corresponding measuring units or monitoring systems (not part of the delivery), permits continuous remote monitoring of the turbocharger speed. With continuous monitoring of the engine installation, the turbocharger speed can be used as a suitable control parameter.

If required, the line amplifier can be purchased as an optional addition to the described speed measuring system.

A reduction in speed of a charger can signify:

- Damaged rotor components or bearing.
- Defects in the connected pulse charging cylinders.
- Defects or leaks on the exhaust gas pipes or on the charge-air lines.



NOTE

With 4-stroke applications, heavy fouling of the turbine can also be a cause of an increase in the turbocharger speed.

Possible reasons for failure of the speed indicator:

- Defects on the speed transmitting system, on the connecting cable, on the measuring unit or in the power supply. (if applicable on the line amplifier or the line amplifier power supply).
- Turbocharger damage.



CAUTION

If the speed indication fails, it is recommended that the engine output be reduced to idling speed and the engine stopped. The cause of the failure should then be determined.

Installation:

If the speed transmitter system is not assembled on the turbocharger at the time of delivery, it will be in a separate package together with its cable.

To assemble, the transmitter system must be screwed into the left or right threaded hole on the bearing casing, depending on the desired position. The screw plug which is in this threaded hole and its seal must first be removed. It should be noted that the sensor is screwed in completely and to the correct tightening torque without a gasket (see chapter Tightening torques table).

Exchange or subsequent assembly of the speed sensor:



NOTE

We recommend that subsequent assembly or replacement of the speed transmitter system should be carried out only by an official ABB Turbo Systems service station.

4.3 Surging of turbocharger

Surging of the turbocharger can occur with certain engine operating states, such as rapid load removal or while manoeuvring. The direction of flow in the compressor is then briefly reversed. However, sporadic surging of this kind does not generally affect the safe operation of the turbocharger.



CAUTION

Prolonged or periodic surging

If surging is prolonged or occurs periodically, the following components may be damaged:

- Compressor wheel (vibration fractures, ...)
- Turbine blades (cracks)
- Bearing (overheating)
- Filter silencer

Action to be taken:

The operating safety of the turbocharger is no longer ensured with continuous or periodically recurring surging. The operator must take immediate steps to correct the surging together with the closest official ABB Turbo Systems service station.

The above mentioned components are to be examined for damage by an official service station of ABB Turbo Systems and replaced in cases of doubt.

4.4 Contact with rotating parts

Mild, uniform wear around the circumference of rotor components, caused by slight local grazing against adjacent components, is non-hazardous and permissible. This slightly reduces the length of the blades in the compressor and/or the turbine. Certain tolerances must be observed to avoid significant loss of efficiency.

- A check on dimensions must be carried out by an official ABB Turbo Systems service station.

4.5 Shutting the engine down



CAUTION

Before shutting the engine down, it must be allowed to idle for a further **5 to 10 Minutes**, so that the circulating oil can dissipate the heat in the turbocharger bearings.

5 Maintenance

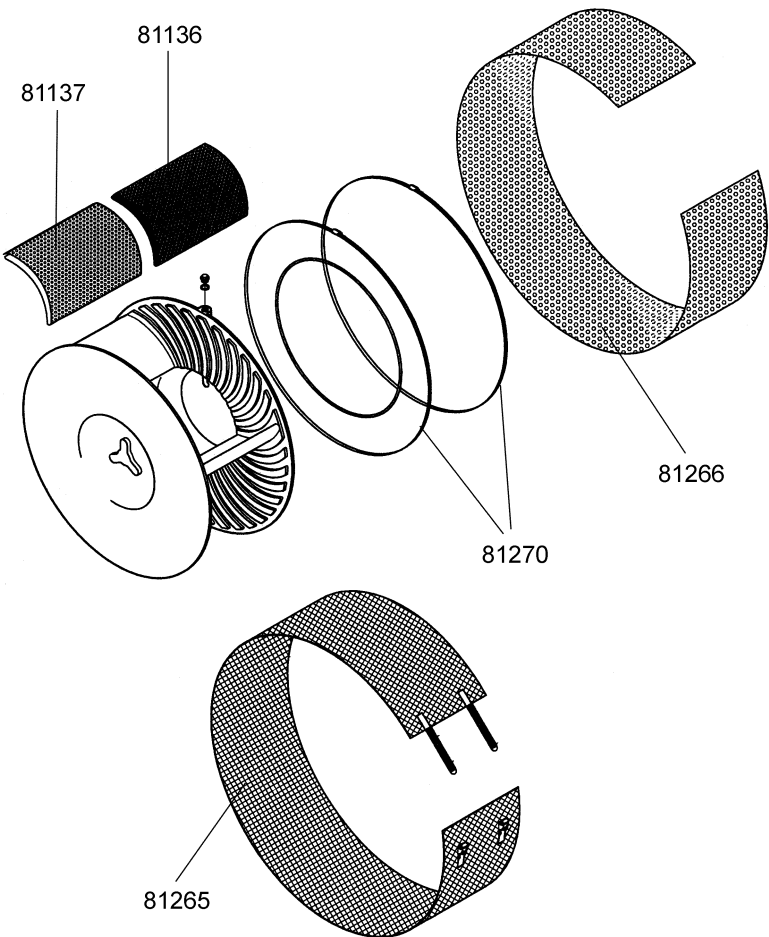
5.1 Outline of cleaning work

Cleaning work includes regular visual checks and washing to ensure the correct functioning of the turbocharger and its auxiliary appliances.

- The external condition and the degree of contamination of the cleaning points listed below must be established by visual checks at the intervals indicated.
- The safety instructions must be observed during all cleaning work.

Filter silencer	▷ Filter ring must be cleaned wet ▶ Dismantle the filter silencer ▶ Felt segments in the cover panels are to be cleaned dry
Compressor	▷ Wet clean with fresh water in accordance with the engine manufacturer's instructions ▶ Engine warm from running ▶ High compressor speed
Turbine	▷ Wet clean with fresh water in accordance with the engine manufacturer's instructions ▶ High engine load ▶ Gas inlet temperature before turbine may not exceed 450°C

5.2 Cleaning the filter silencer



S_00116

If provided

The filter ring (81265) can be replaced or cleaned by washing.



NOTE

To ensure perfect operation during washing it is advisable to replace the filter ring with another (filter rings available in packs of two).



CAUTION

Wash or replace the filter ring every 500 service hours. The filter ring is not to be washed more than five times.

September 2005

HZTL2410_EN (TPS48-61)

Version 2

September 2005

- Washing the filter ring**
- Cleaning the silencer**
- ▶ Rinse filter ring with water (up to 40°C) using fine washing powder or, if very dirty, soak it and squeeze out carefully. Rinse in cold water. Avoid high mechanical stress (wringing, strong water jet).
 - ▶ Allow the filter ring to dry completely before assembly.
 - ▶ Loosen the tension bands (81270) and withdraw cover grid (81266).
 - ▶ Withdraw the cover panels (81137), bend them upwards and remove the felt segments (81136).



CAUTION

During cleaning take care that the felt segments do not get wet!

- ▶ Remove dirt with a cloth, a soft brush or compressed air.
- ▶ Have heavily soiled felt segments replaced by an ABB Turbo Systems service station.



CAUTION

Damaged tension bands must be replaced with new ones.

HZTL2410_EN (TPS48-61)

Version 2

5.3 Cleaning the compressor during operation

The dirt in the compressor stage (compressor wheel and diffuser) depends on the cleanness of the air drawn in and the operating point.

A deposit of dirt in the flow ducts will be formed if the following substances are present in the intake air:

- Oil or saline mist
- Solid combustion residues
- Dust of various kinds

Soiling of the compressor stage has a negative effect on compressor efficiency and charging pressure, particularly for smaller turbochargers.

This results in higher exhaust temperatures and increased fuel consumption by the engine. Contamination of the compressor also increases the rotor unbalance.

Periodic cleaning of the compressor in operation prevents or retards an increase in soiling, but in no way replaces the regular servicing work, during which the turbocharger is completely dismantled.



NOTE

If the coating of dirt is very thick and hard, the compressor can only be cleaned manually when dismantled. This cleaning should be carried out by an official ABB Turbo Systems service station.

Principle of wet cleaning

Water is injected before the compressor wheel via an injection pipe fitted in the filter silencer or the suction branch in order to clean the compressor stage in operation.

The water does not act as a solvent in the process, but the deposit is removed by the mechanical impact of the drops. The process is ideal, provided the soiling is not too advanced.

5.3.1 Wet cleaning of the compressor



NOTE

These guidelines for wet cleaning the compressor apply exclusively for cleaning with water and are subject to the approval of the **engine manufacturer**.



CAUTION

Due to the danger of corrosion, only **fresh water** may be used, and on no account salt water. The water should also not contain any cooling additives or solvents, which could form deposits in the flow ducts.

The injection pipe must on no account be connected directly via a cock to a water pipe or a dosing vessel larger than the one supplied. This prevents uncontrolled volumes of water entering the turbocharger and engine, which can lead to serious damage.

Cleaning interval

The interval between periodic cleanings depends in large measure on the operating conditions. In general, cleaning should be carried out every **24 to 72 operating hours**.

Engine load during wet cleaning

Cleaning of the compressor stage must be performed with the engine warm from running and **as fully loaded** as possible (i.e. at high turbocharger speed).

The success of the cleaning can be seen from the charging or scavenging pressure or also from the exhaust gas temperatures. If cleaning is unsuccessful, it can be repeated up to 2 times.

An unsuccessful cleaning should be repeated after a stabilisation period of 10 minutes at the earliest.



NOTE

If cleaning is still unsuccessful after three attempts, and if the engine operating values are unsatisfactory, we recommend that the turbocharger be checked and cleaned by an official ABB Turbo Systems service station.

After cleaning the compressor stage, the engine must be run under load for at least another **5 minutes**.

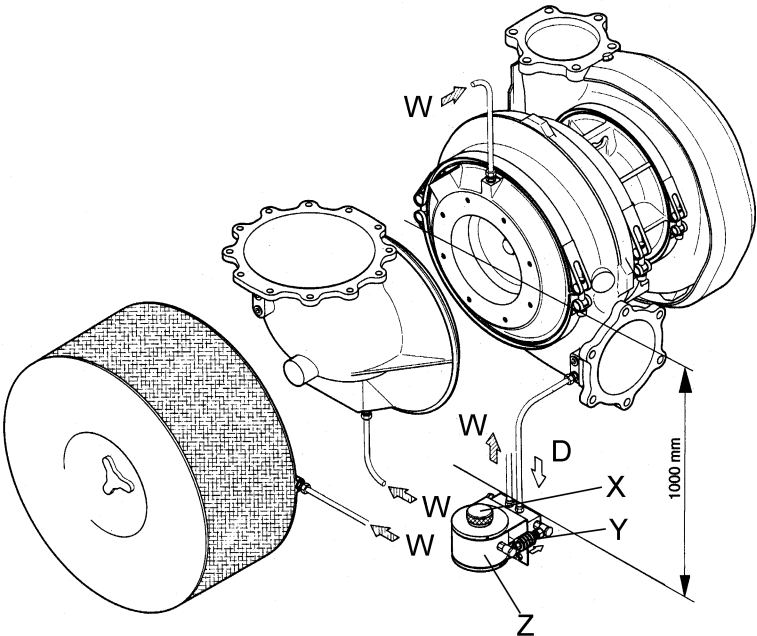
Cleaning more than one turbocharger compressor

If several turbochargers are installed on one engine, we recommend cleaning the turbocharger compressors one after the other.

5.3.2 Wet cleaning with external pressurised water container



The supply of water from the externally mounted dosing vessel is not suitable for applications where underpressure is not present before the compressor wheel (e.g.: Blower connected upstream of the compressor or high-pressure compressor stage in the case of two-stage charging).



S_00097

X	Screw plugs	D	Compressed air
Y	Valve lever	W	Water
Z	Container		

September 2005

HZTL2410_EN (TPS48-61)

Version 2

Cleaning parameters for each turbocharger compressor

Turbocharger type	Turbocharger speed	Contents of the dosing vessel [dm³]	Water injection time t ₁ [s]
TPS 48	roughly n _{Bmax}	0.4	10
TPS 52			
TPS 57			
TPS 61			

Operating the pressure water vessel

- ▶ Remove the screw plug (X).
- ▶ Fill the vessel with pure water.
- ▶ Screw the screw plug back in place.
- ▶ Actuate valve lever(Y) against the spring and hold it for **10 to 15 seconds** until all the water has been injected.

September 2005

HZTL2410_EN (TPS48-61)

Version 2

5.4 Cleaning turbine blades and nozzle ring in operation

Combustion of heavy fuel oil in diesel engines causes soiling of the turbine blades and nozzle rings of the turbochargers. Heavy fuel oil of particularly poor quality in combination with a high exhaust gas temperature, as occurs with a 4-stroke engine, can lead to particularly hard deposits, above all on the nozzle ring.

Poor turbine efficiency, increased exhaust gas temperatures, higher charging and ignition pressures and a lower engine output are the result.

Experience in operation shows, that with periodical cleaning during operation, the interval between overhauls can be extended. The wet cleaning of the turbine blades and the nozzle ring described in the following can be applied with 4-stroke applications with heavy fuel oil and gas engines with heavy deposits (e.g. waste dump gas).

For the other applications, in general no turbine cleaning is necessary.



NOTE

Regular cleaning of the turbine during operation prevents or retards a severe increase in soiling.

This cleaning does not replace the normal maintenance work, during which the turbocharger is to be completely dismantled.



NOTE

Very heavily soiled turbochargers are not to be cleaned with this method. In this case, the rotor must be cleaned by an official ABB Turbo Systems service station.

Wet cleaning

Wet cleaning is used for TPS turbochargers.

To clean the turbine components during operation, the thermal shock principle is applied in combination with a subsequent flushing phase. During the cleaning process, the layer of dirt on the material surface of the turbine components loosens.

**CAUTION**

Only clean fresh water without cleaning agents or solvents may be used for the wet cleaning.

**NOTE**

The instructions of the engine manufacturer for wet cleaning are to be observed.

To achieve the required thermal shock effect for wet cleaning, the temperature before the turbine T_{Ti} must lie between 400°C (673 K) and 450°C (723 K).

**CAUTION**

For reasons of material strength, during the cleaning process the temperature before the turbine T_{Ti} must not exceed 450°C (723 K).

If the exhaust gas temperature can be reduced for wet cleaning, we recommend this should be done as far as possible, to reduce stress on the material, but the exhaust gas temperature must not be reduced below 400°C (673 K).

The prescribed water injection pressure and the duration of water injection must be observed without fail.

Smaller volumes of water can lead to an inadequate cleaning effect. Larger volumes of water lead to impermissible thermal stresses.

Clean fresh water free from cleaning agents and solvents must be used.

Cleaning turbine blades and nozzle ring in operation 5.4

Page 10

Cleaning more than one turbocharger turbine

If on a single engine, more than one turbocharger is mounted feeding into the same air receiver, the turbochargers are to be cleaned one after the other.

The cleaning of all turbochargers at the same time causes a greater drop in performance.

To avoid corrosion on the inner surfaces of the casing, the engine must be run for a further 10 minutes after the wet cleaning operation is completed.

Cleaning interval

The frequency of the cleaning depends on the extent of soiling. As a guidance value, the turbine components are to be cleaned approx. every 200 service hours.

If required, this cleaning interval can be shortened after consultation with ABB Turbo Systems.

Requirement for water supply

During the injection, the absolute static water pressure p_{WT} before the water connection on the turbine casing must be at least 1.5 bar above the absolute turbine inlet pressure ($p_{WT} - p_{Ti} \geq 1.5 \text{ bar}$).

If necessary, the engine load must be lowered during cleaning.

- p_{WT} = absolute static pressure before water connection on turbine casing
- p_{Ti} = absolute static pressure before the turbine

**CAUTION**

The water supply line to the turbine casing must on no account be connected to a water pipe directly via a cock.

Wet cleaning procedure

Check that the temperature before the turbine T_{Ti} is between 400°C (673 K) and 450°C (723 K). If necessary the engine output is to be adapted.

The engine output must also be lowered if $p_{WT} - p_{Ti} \geq 1.5$ bar.

**NOTE**

If $T_{Ti} = 400^\circ\text{C}$ can not be achieved ($T_{Ti} < 400^\circ\text{C}$), then the temperature should be set as high as possible.

- ▷ Check that the water supply is ensured.
- ▶ Open shut-off valve
- ▶ Inject water with pressure p_{WT} for 15 to 30 seconds
(As standard 15 seconds are recommended. Extend the injection period if cleaning effect with 15 seconds is unsatisfactory and if engine operation permits this.)
- ▶ Reheating phase of the turbocharger components over a time t_h according to the following table „Cleaning parameters“.
- ▶ Repeat the last 2 previous points until water has been injected three times.
- ▶ This completes the turbine cleaning process. The shut-off valve must be closed.

**NOTE**

If an engine is charged by more than one turbocharger, to save time the turbines should be cleaned sequentially. That means, that during the reheating phase of one turbocharger, the water injection can take place at the next one.

Cleaning parameters

Type	Temperature before turbine [°C]	Water Absolute pressure ¹⁾ [bar]	Injection period per injection [s]
TPS 48	400 ... 450	3,5 ... 6,0	15 ... 30
TPS 52	400 ... 450	3,5 ... 6,0	15 ... 30
TPS 57	400 ... 450	3,5 ... 6,0	15 ... 30
TPS 61	400 ... 450	3,5 ... 6,0	15 ... 30

Type	Water volume per injection ²⁾ [l]	Pause between the injections [min]	Number of water injections
TPS 48	1,5 ... 3,5	3	3
TPS 52	2,0 ... 5,0	3	3
TPS 57	3,5 ... 8,0	3	3
TPS 61	5,0 ... 12,0	5	3

¹⁾ Before the water connection on the turbine casing during cleaning

²⁾ Water volume depending on pressure before turbine, water injection pressure and injection period



CAUTION

The specified water volume is per turbocharger.

5.5 Maintenance work

Maintenance work includes inspection and function checks of wearing parts with or without changing process materials, parts or modules. It must be carried out in accordance with the intervals as set out in the Outline of Maintenance work.



CAUTION

Failure to conduct scheduled maintenance work

Failure to carry out the maintenance work at the prescribed intervals can lead to damage and malfunction of the turbocharger. The safety instructions in the respective chapters must be observed for all maintenance work. Keep lubrication and auxiliary materials ready

Overview of maintenance work

- ▶ Completely replace bearings in accordance with the instructions on the rating plate and/or as indicated by the service station or in case of damage.
- ▶ Replace compressor wheel in accordance with the instructions on the rating plate and/or as indicated by the service station or in case of damage.
- ▶ Replace turbine in accordance with the instructions on the rating plate and/or as indicated by the service station or in case of damage.



NOTE

These operations must be carried out by an authorised ABB Turbo Systems service station.

6 Troubleshooting

6.1 Possible remedies for failures

6.1.1 Exhaust temperature too high

Engine output and speed unchanged

Engine

- ▷ Malfunction in the injection system
- ▶ Repair, or contact the manufacturer.

Turbocharger

- ▷ Air starvation, e.g. air filter clogged with dirt
- ▶ Clean
- ▷ Compressor / turbine soiled
- ▶ Clean
- ▷ Exhaust counterpressure too high
- ▶ Clean or repair boiler or exhaust silencer
- ▷ Turbine damaged or worn
- ▶ Contact an official ABB Turbo Systems service station.

Charge-air cooler

- ▷ Cooler soiled
- ▶ Clean
- ▷ Insufficient coolant water quantity
- ▶ Replenish
- ▷ Coolant water inlet temperature too hot
- ▶ Clean/inspect cooling system
- ▷ Ventilation inadequate
- ▶ Improve ventilation

6.1.2 Charge-air pressure too low

Engine output and speed unchanged

Intake condition normal

Engine

- ▷ Air receiver leaking
 - ▶ Repair
- ▷ Gas line between engine and turbine leaking
 - ▶ Repair
- ▷ Injection misadjusted
 - ▶ Correct adjustment
- ▷ Valve control misadjusted
 - ▶ Correct adjustment

Turbocharger

- ▷ Manometer display faulty
 - ▶ Replace manometer
- ▷ Leak in line to the manometer
 - ▶ Repair leak
- ▷ Air filter dirty, causing excessive loss of pressure
 - ▶ Clean
- ▷ Compressor / turbine soiled
 - ▶ Clean
- ▷ Compressor / turbine damaged
 - ▶ Contact an official ABB Turbo Systems service station.
- ▷ Excessive exhaust counterpressure
 - ▶ Clean boiler or exhaust silencer

September 2005

HZTL2410_EN (TPS48-61)

Version 2

6.1.3 Charge-air pressure too high

Engine output and speed unchanged
Intake condition normal

Engine

- ▷ Malfunction in the injection system
- ▶ Correct adjustment
- ▷ Engine output higher than expected
- ▶ Check engine output
- ▷ Injection misadjusted
- ▶ Correct adjustment

Turbocharger

- ▷ Manometer display faulty
- ▶ Replace manometer

6.1.4 Vibrations

Turbocharger

- ▷ Rotor imbalance due to heavy fouling of compressor/turbine
- ▷ Turbine or compressor damaged
- ▷ Bearing defective
- ▶ Contact an official ABB Turbo Systems service station.

6.1.5 Noises during run-out

Turbocharger

- ▷ Turbocharger dirty
- ▶ Clean
- ▷ Bearing damaged
- ▷ Rotor grazing
- ▷ Foreign bodies in the turbocharger
- ▶ Contact an official ABB Turbo Systems service station.

6.1.6 Run-out time too short

Turbocharger

- ▷ Turbocharger dirty
 - ▶ Clean
- ▷ Bearing damaged
- ▷ Rotor grazing
- ▷ Foreign bodies in the turbocharger
 - ▶ Contact an official ABB Turbo Systems service station.

6.1.7 Sluggish start-up

Turbocharger

- ▷ Turbocharger dirty
 - ▶ Clean
- ▷ Bearing damaged
- ▷ Rotor grazing
- ▷ Foreign bodies in the turbocharger
 - ▶ Contact an official ABB Turbo Systems service station.

6.1.8 Lubricating oil pressure too low

Engine

- ▷ Oil filter heavily soiled
 - ▶ Clean
- ▷ Oil pump in the lubricating system defective
 - ▶ Inspect
- ▷ Manometer provides false reading
 - ▶ Replace manometer

Turbocharger

- ▷ Axial clearance of the rotor too big
 - ▶ Contact an official ABB Turbo Systems service station.

6.1.9 Constant surging of the turbocharger

Engine

- ▷ Exhaust pressure to the turbine elevated because boiler or exhaust silencer is dirty
- ▷ Trap dirty
- ▶ Clean

Turbocharger

- ▷ Charge-air cooler or silencer dirty
- ▷ Heavy deposits of contamination in the turbine
- ▶ Clean



NOTE

If it is not possible to determine the reason for the surging, contact an official ABB Turbo Systems service station.

7 Removal and installation

7.1 Turbocharger weights

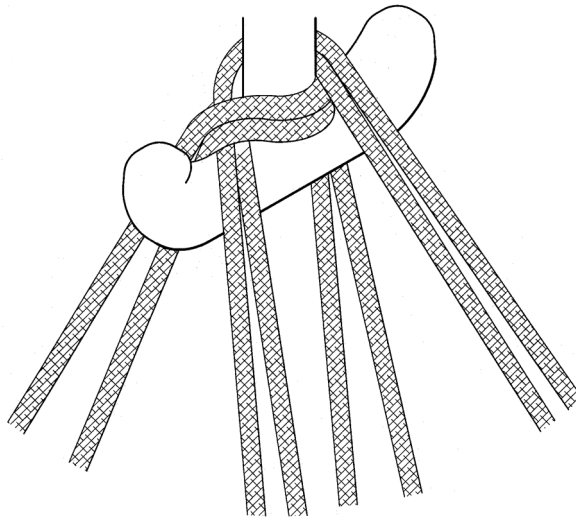


WARNING

Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.

Turbocharger parts that are not suspended in accordance with the regulations during disassembly and assembly may fall and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.



L_00082



NOTE

To ensure the safety of loads on the crane hook, the ropes must be crossed for suspending. See also the illustration above.

Turbocharger complete without silencer / air suction branch and without gas outlet manifold

Weight [kg]

TPS 48	TPS 52	TPS 57	TPS 61
110	160	260	450

Turbocharger complete without gas outlet manifold and with silencer

Weight [kg]

TPS 48	TPS 52	TPS 57	TPS 61
129	187	300	512

Turbocharger complete without gas outlet manifold and with air suction branch (radial)

Weight [kg]

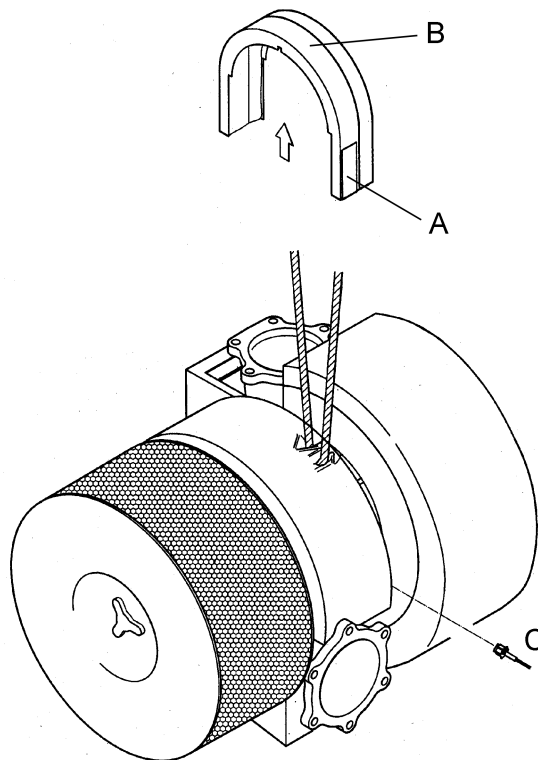
TPS 48	TPS 52	TPS 57	TPS 61
116	168	271	471

7.2 Remove the turbocharger

- Disconnect all gas and air lines in accordance with the engine manufacturer's instructions.

If provided

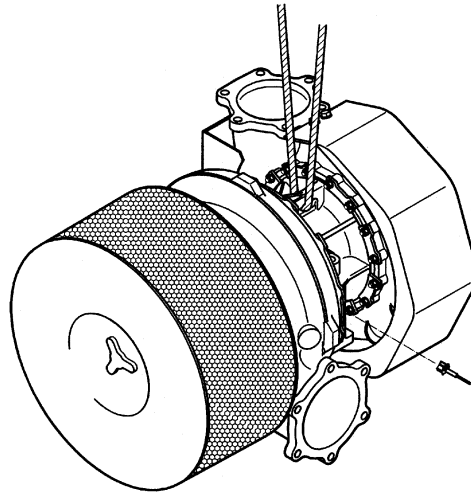
Remove insulation as follows:



S_00098

- Remove screws and plate (A) of the bearing casing insulation.
- Remove remaining screws of the bearing casing insulation (B).
- Withdraw bearing casing insulation upwards. For more simple removal, the bearing casing insulation can be compressed.
- Unplug cable on the speed measurement (C).
- Check the lifting equipment.

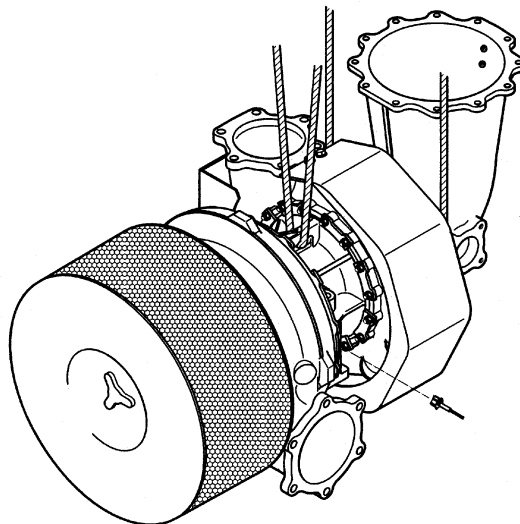
Turbocharger without gas outlet manifold



S_00099

- Secure lifting equipment to bearing casing.

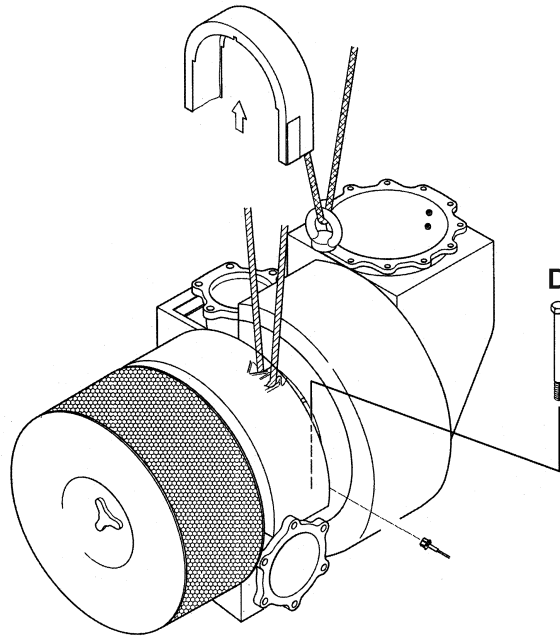
Turbocharger with gas outlet manifold without insulation:



S_00100

- Sling lifting equipment around the gas outlet manifold and secure to the bearing casing.

Turbocharger with gas outlet manifold and with insulation:



S_00101

- ▶ Secure lifting equipment with a ring bolt and nut to the flange of the gas outlet manifold and to the bearing casing.



WARNING

During removal, a turbocharger that is not lifted in compliance with regulations may fall, and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger.
- ▶ Loosen securing screws (**D**) on the bearing casing.
- ▶ Lift the turbocharger from the engine and place it aside.
- ▶ Cover oil connections.

7.3 Installing the turbocharger

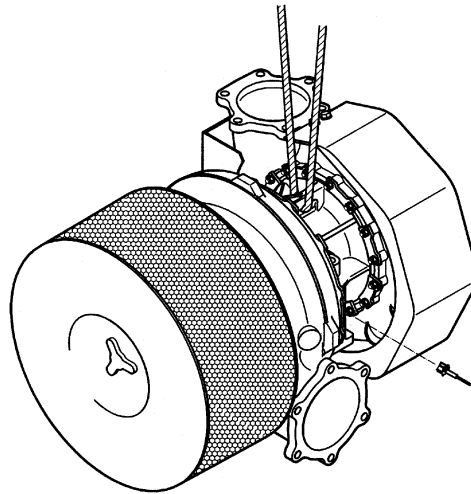


During installation, a turbocharger that is not lifted in compliance with regulations may fall, and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger.

- ▶ Remove covers from the oil connections.
- ▶ Visual inspection of the O-ring gaskets of oil supply- and drain pipe (the engine-end O-ring gaskets are not part of the scope of delivery of ABB Turbo Systems).
- ▶ Check the lifting equipment.

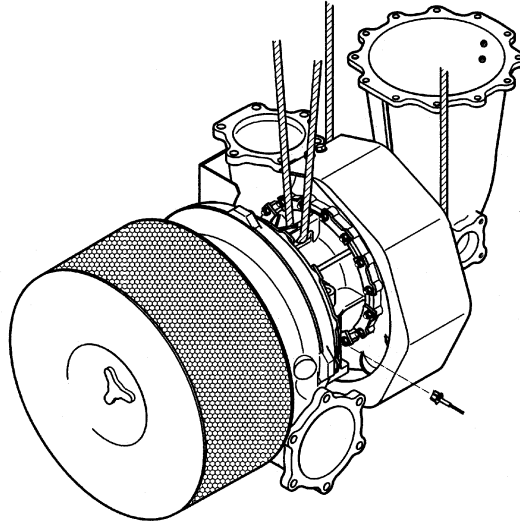
Turbocharger without gas outlet manifold



S_00099

- ▶ Secure lifting equipment to bearing casing

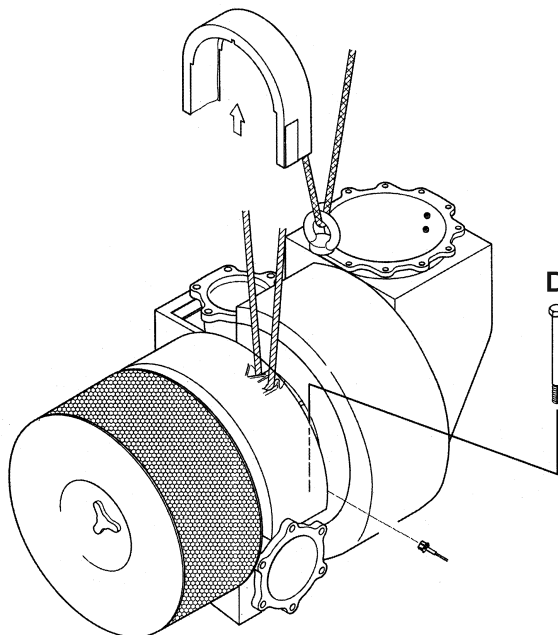
Turbocharger with gas outlet manifold without insulation:



S_00100

- Sling lifting equipment around the gas outlet manifold and secure to the bearing casing.

Turbocharger with gas outlet manifold and with insulation:



S_00101

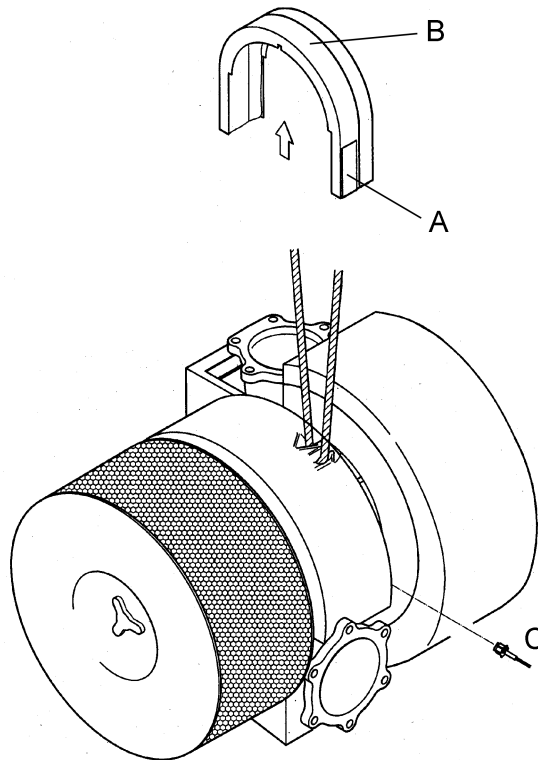
- ▶ Secure lifting equipment with a ring bolt and nut to the flange of the gas outlet manifold and to the bearing casing.
- ▶ Mate turbocharger with the engine.
- ▶ Tighten securing screws (D) on the bearing casing.
- ▶ Plug in cable for the speed measurement (C).

September 2005

If provided:

Secure insulation as follows:

- ▶ Mate bearing casing insulation.



S_00098

- ▶ Tighten screws of the bearing casing insulation (B).
- ▶ Mate screws and plate (A) of the bearing casing insulation.
- ▶ Secure all gas and air lines in accordance with the engine manufacturer's instructions.

HZTL2410_EN (TPS48-61)

Version 2

8 Disassembly and assembly

8.1 Module weights

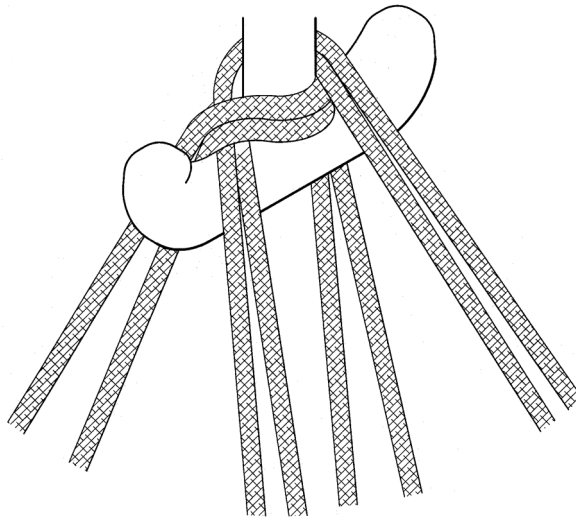


WARNING

Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.

Turbocharger parts that are not suspended in accordance with the regulations during disassembly and assembly may fall and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.



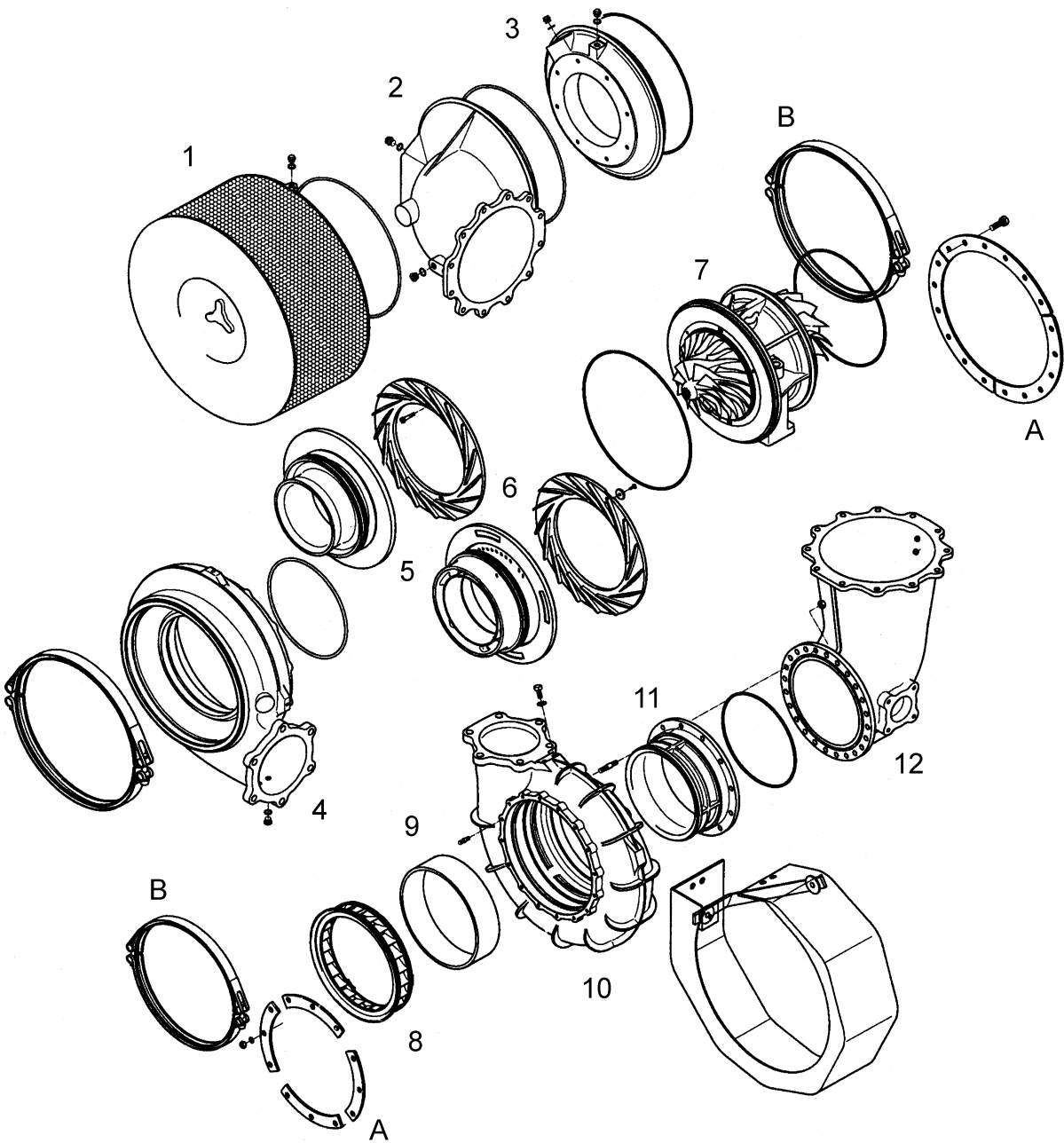
L_00082



NOTE

To ensure the safety of loads on the crane hook, the ropes must be crossed for suspending. See also the illustration above.

Modules



S_00102

A	Strap connection	B	V-band connection
---	------------------	---	-------------------

September 2005

HZTL2410_EN (TPS48-61)

Version 2

Weights [kg]

	Description		TPS 48	TPS 52	TPS 57	TPS 61
1	Silencer		19	27	40	62
2	Air suction branch, radial		6	8	11	21
3	Air suction branch, axial		4	4	6	9
4	Compressor casing		24	35	51	89
5	Wall insert		7	10	13	30
6	Diffuser		2	3	6	10
7	Cartridge group		32	48	83	136
8	Nozzle ring		1	2	3	6
9	Rupture ring		2	3	5	12
10	Turbine casing with external rupture protec- tion	1 inlet	32	47	77	130
		2 inlets	35	50	86	145
		3 inlets	-	53	96	162
		4 inlets	-	-	93	162
11	Gas outlet flange		4	8	16	30
12	Gas outlet manifold		18	25	40	56

8.2 Disassembling and assembling turbocharger (with V-band connection)



NOTE

Not all tools are identified with a part number. The identification of the tools is ensured with the tools list (included in the toolbox).



WARNING

During removal and assembly, turbocharger components that have not been suspended in compliance with regulations may fall, and can cause serious or even fatal injury.

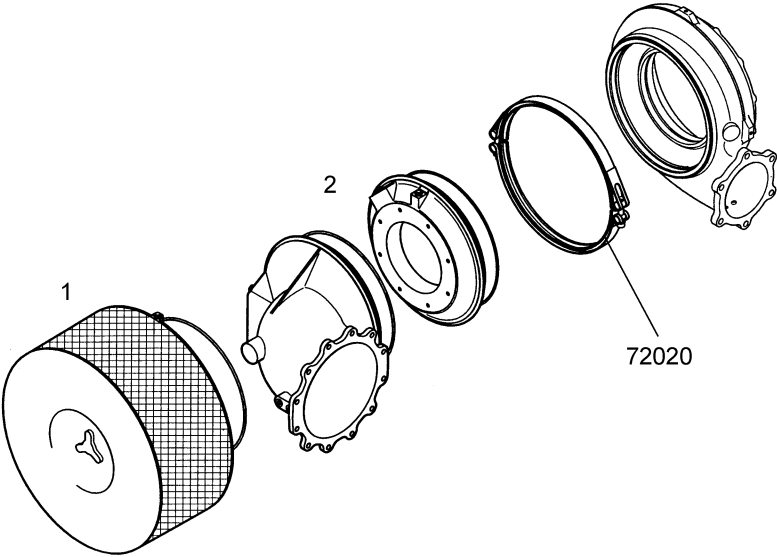
- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.

Removing compressor casing

- ▶ Disconnect all air ducts in accordance with the engine manufacturer's instructions.

If provided:

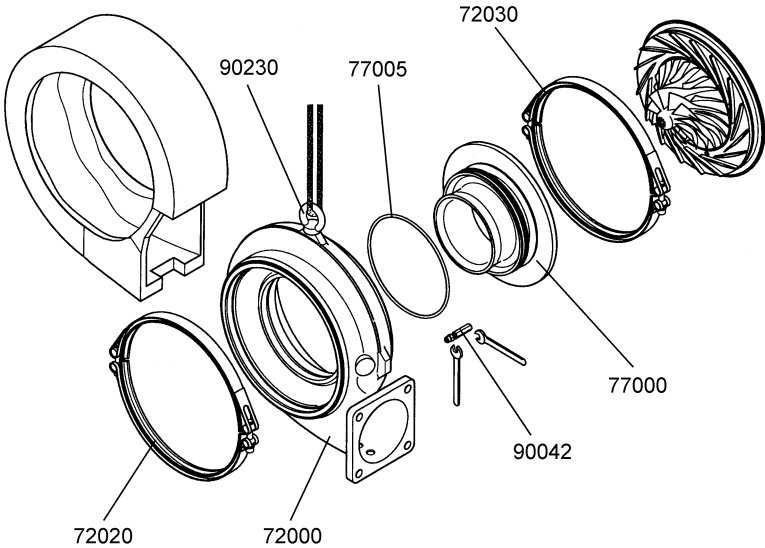
- ▶ Remove screws of the compressor casing insulation and dismantle insulation.
- ▶ Loosen V-band (72020) and remove filter silencer or air suction branch.



S_00103

1	Filter silencer	2	Air suction branch
---	-----------------	---	--------------------

- ▶ Slightly loosen V-band (72030) and turn compressor casing (72000), until the ring bolt (90230) on the lifting equipment can be secured.
- ▶ Completely loosen V-band (72030) and travel compressor casing (72000) away horizontally with wall insert (77000).
- ▶ Knock wall insert (77000) out of the compressor casing with nylon hammer and remove O-ring gasket (77005).



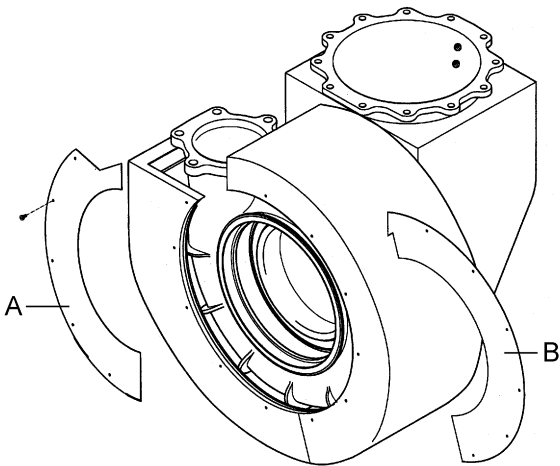
S_00104



NOTE

If the compressor casing can not be easily released, it can be pushed off against the turbine casing with the press-off tool (90042). For this, the two cover plates (A+B) of the turbine casing insulation must be removed.

If provided



S_00105



Axial force

A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

- Therefore always engage at both sides alternately and do not press off too much at each side.

Installing compressor casing

- ▶ Install the compressor casing following these instructions in the reverse order.



NOTE

Always replace O-ring gaskets (see section **Spare parts**)

- ▶ Clean V-bands (72020/72030) thoroughly before assembly.
- ▶ Grease V-band thread and inside of the profile with Antiscuff (or similar high-temperature lubricating paste).
- ▶ Check lifting equipment and secure to bearing casing (42001).

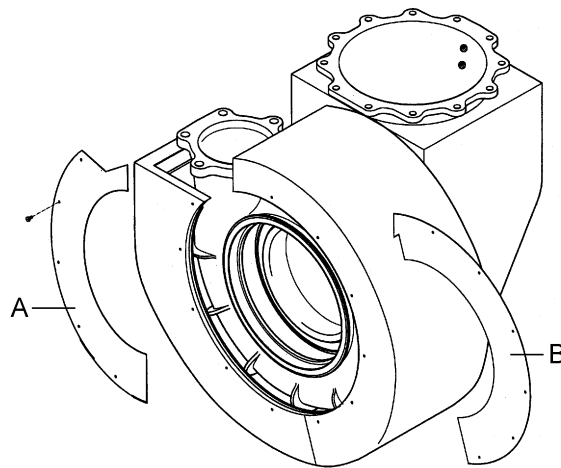


CAUTION

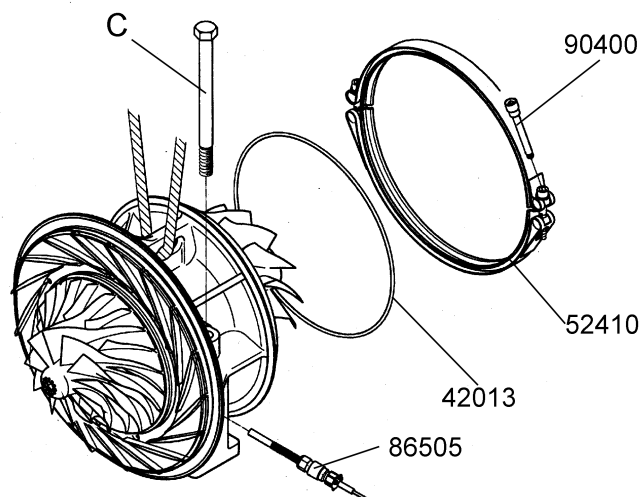
Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

Removing cartridge group**If provided**

- Disconnect all lines according to engine manufacturer's specifications, remove insulation, dismantle turbocharger and remove compressor casing as well as filter silencer (see also previous chapter).

*S_00105*

- Remove screws on both plates (A+B) of the turbine casing insulation and dismantle the plates.

*S_00106***If provided**

- Disconnect plug to speed measuring transmitter (86505).

- ▶ Treat screw thread of the V-band (52410) with rust dissolver and allow to act.
- ▶ Loosen V-band (52410) with hexagon insert (90400) and remove.
- ▶ Loosen fastening screws (C) of the bearing casing (42001) and remove.
- ▶ Carefully withdraw cartridge group and remove gasket (42013).
- ▷ Bearing casing is not easy to remove.
- ▶ Press off bearing casing with press-off tool (90042) against the turbine casing (see following diagram).



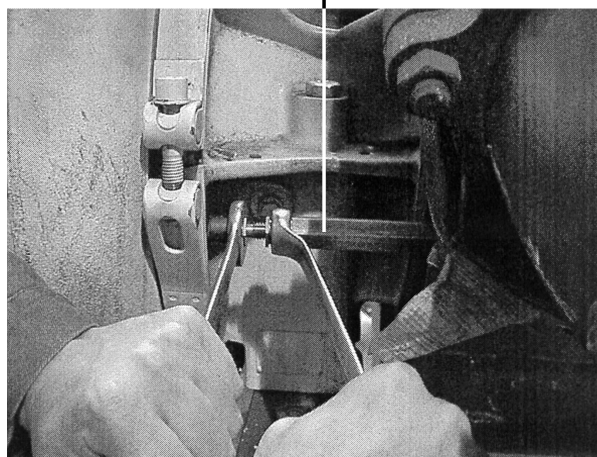
CAUTION

Axial force

A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

- ▶ Therefore always engage at both sides alternately and do not press off too much at each side.

90042



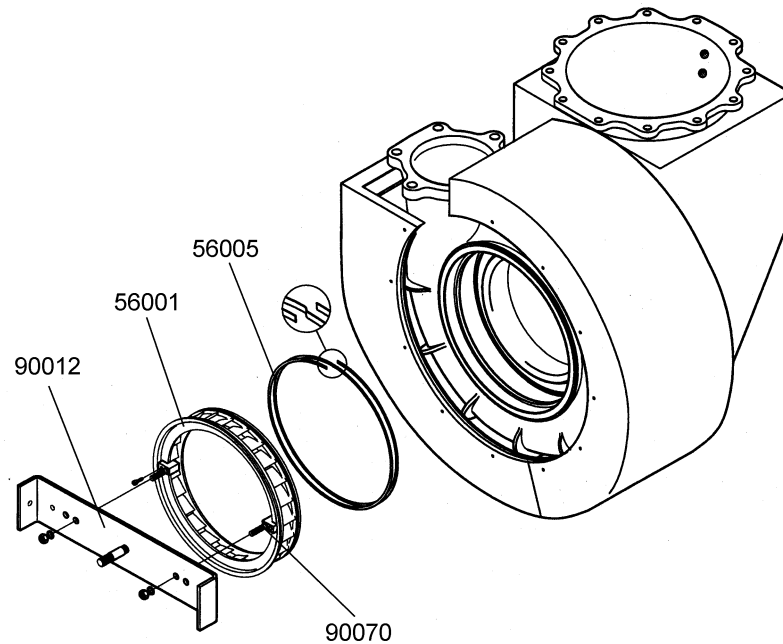
S_00128

- ▶ Cover oil connections.



NOTE

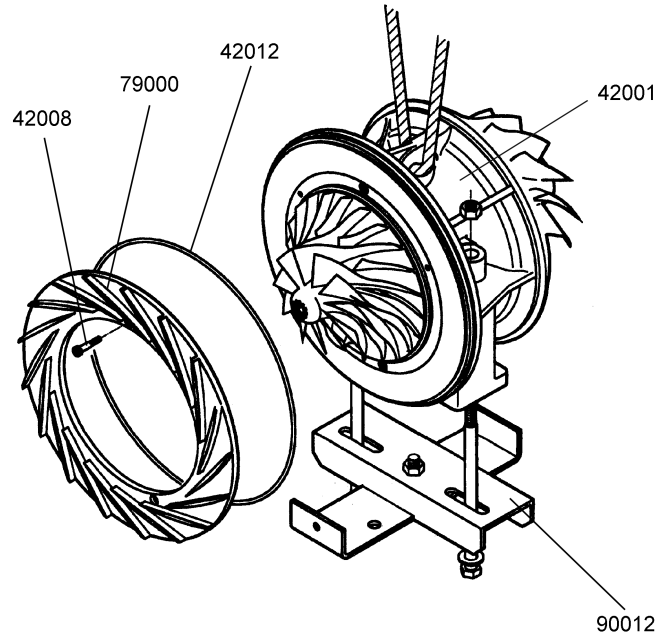
The V-band (52410) is always to be replaced by a new one. (see section **Spare parts**)

*S_00107*

- ▶ Press off nozzle ring (56001) with the two withdrawal devices (90070) and the service support bracket (90012) and remove.

If provided:

- ▶ Remove lamellar sealing ring (56005).
- ▶ Place cartridge group on the service support (90012) and screw tight.

Diffusor disassembly
TPS...D/E/F33*S_00110*

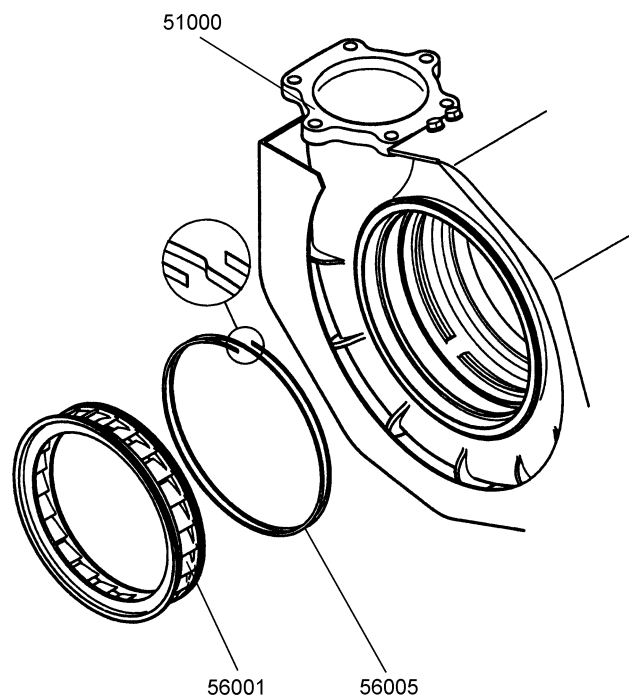
- ▶ Loosen screws (42008), remove diffuser (79000) and O-ring gasket (42012).
- ▶ Measure axial and radial clearances (see section **Axial and Radial Clearances**).

Installing the cartridge group



NOTE

Always replace O-ring gaskets (see section **Spare parts**)



S_00109

If provided:

- ▶ Fit lamellar sealing ring (56005).



NOTE

Ensure the correct coiling of the lamellar sealing ring (56005).

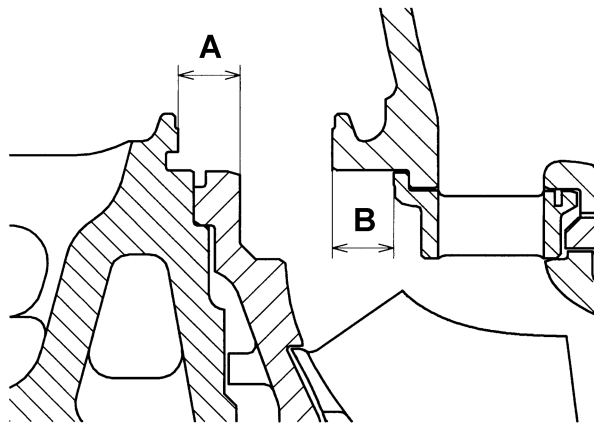
- ▶ Push in nozzle ring (56001) up to the stop in the turbine casing (51000).
- ▶ Pay attention to the position of the cam.



NOTE

So that the nozzle ring is fixed during operation, it must be clamped between the partition wall and the turbine casing.

- The pressing (PD) must be calculated.



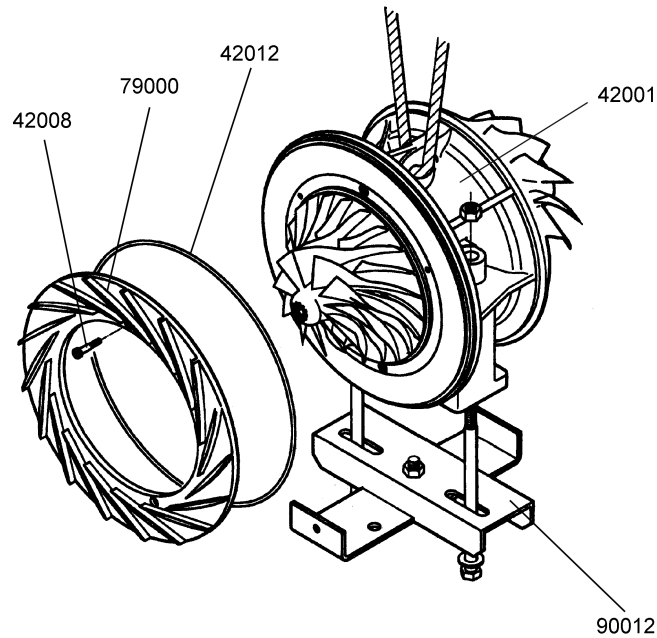
$$PD = A - B$$

S_00129

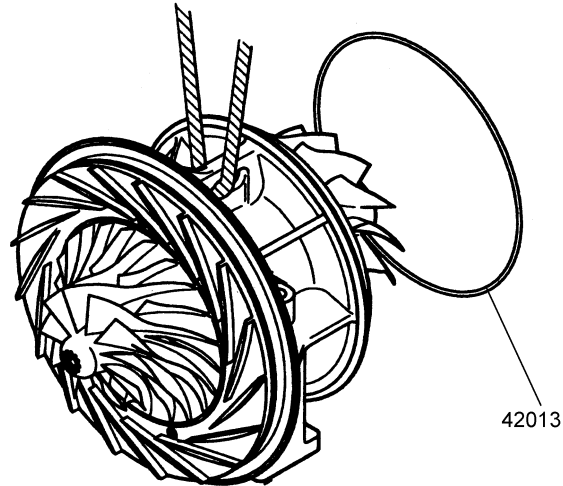


NOTE

If the calculated value is less than **0.1 mm**, an official service station of ABB Turbo Systems must be contacted.

*S_00110*

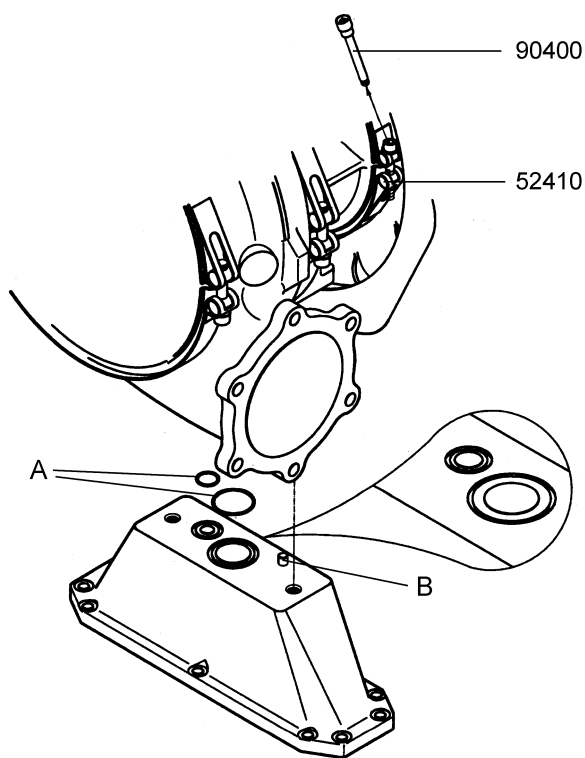
- ▶ Measuring axial and radial clearances (see section Axial and Radial Clearances).
- ▶ Secure diffuser (79000) and O-ring gasket (42012) with screws (42008).
- ▶ Check lifting equipment and secure to bearing casing (42001).
- ▶ Unscrew cartridge group and lift from the service support (90012).

*S_00111*

- ▶ Grease centering seats, inside of the V-band profile and screw threads with Antiscuff (or similar high-temperature lubricating paste).
- ▶ Remove provisional covers at the oil connections.
- ▶ Assemble cartridge group and gasket (42013) as far as possible by hand.

**CAUTION**

During assembly of the cartridge group, do not damage or move gasket rings (A) in the securing support. The gasket rings (A) are engine side and are not included in the scope of supply of ABB Turbo Systems.



S_00112

**NOTE**

If two turbochargers, each with a left and right oil inlet, are mounted on one engine, as a precaution against mistaken, incorrect assembly, a pin can be fitted in the bracket as assembly security device. This pin (B) fits in the respective groove on the foot of the bearing casing.

- ▶ Fit V-band (52410) and tighten using hexagon insert (90400) to the specified torque. (use torque spanner!).
- ▶ Loosen V-band and remove.
- ▶ Measure the distance between the V-band flanges at several points with a feeler gauge. This distance must not be greater than the calculated value (PD).

**CAUTION****Correct positioning of the turbine casing**

Operation of the TPS turbocharger with axially incorrect positioned turbine casing leads to damage to the nozzle ring and turbine casing.

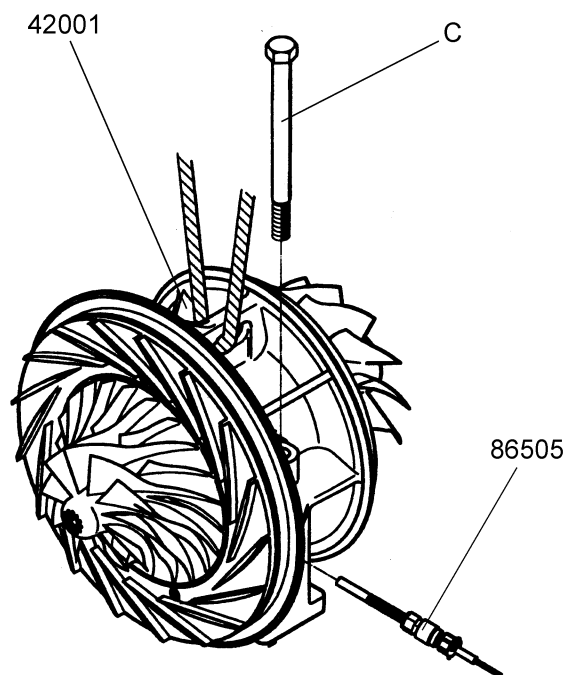
- ▶ If the calculated value is not achieved, repeat tightening procedure with V-band (do not tighten V-band with more than the specified torque) or separate casing with press-off tool and start from the beginning.
- ▶ Fit V-band and tighten with the specified torque.



NOTE

An optimal seating of the V-band is achieved through gentle taps on the cover band with a nylon hammer.

- ▶ Retighten V-band with torque spanner (see chapter Tightening torques table).



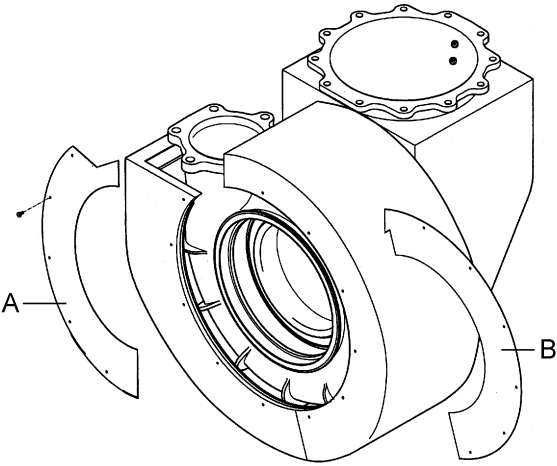
S_00113

- ▶ Assemble bearing casing (42001) with fixing screws (C).
- ▶ Tighten fixing screws with the torques specified in the following table.

TPS	Fixing screws C [mm]	Tightening torques [Nm]
48	M16	230
52	M20	455
57	M20	455
61	M24	780

► Fit speed sensor (86505).

If provided:



S_00105

► Fit insulation plates (A+B).



CAUTION

Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

8.3 Disassembling and assembling turbocharger (with strap connection)



NOTE

Not all tools are identified with a part number. The identification of the tools is ensured with the tools list (included in the toolbox).



WARNING

Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.

Turbocharger parts that are not suspended in accordance with the regulations during disassembly and assembly may fall and can cause serious or even fatal injury.

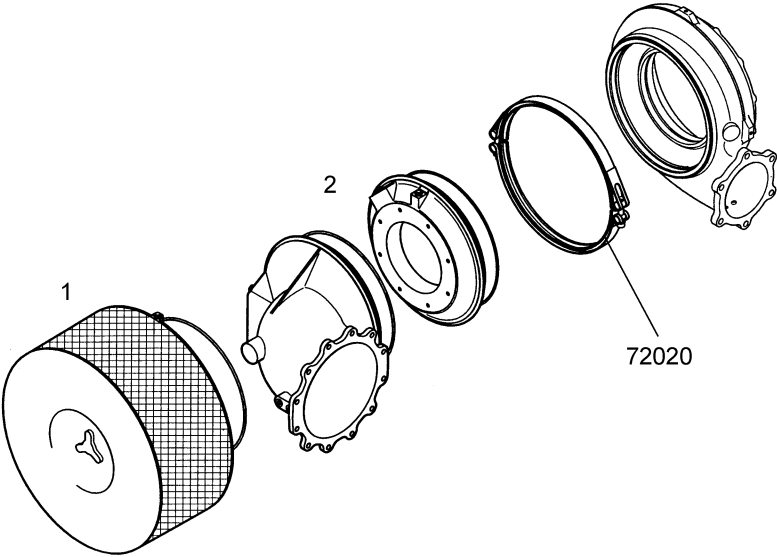
- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.

Removing compressor casing

- ▶ Disconnect all air ducts in accordance with the engine manufacturer's instructions.

If provided

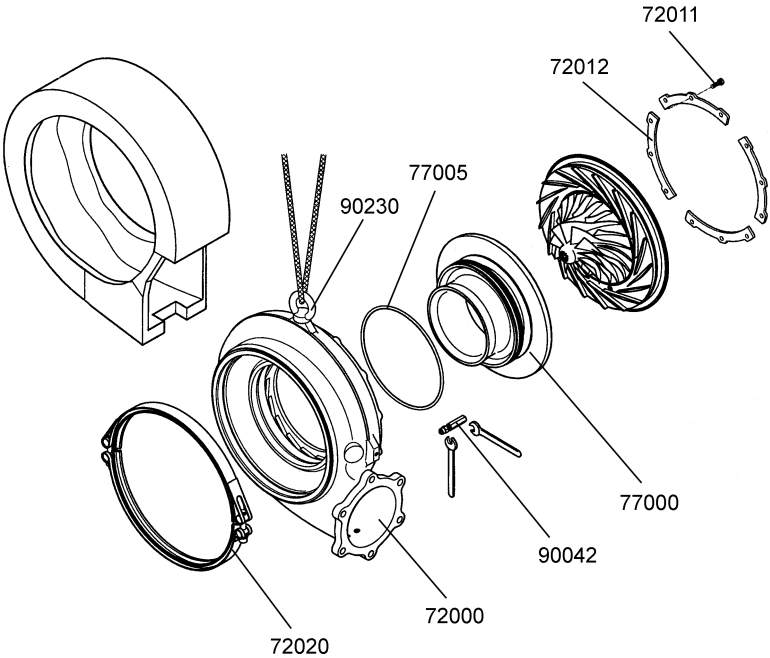
- ▶ Remove screws of the compressor casing insulation and dismantle insulation.
- ▶ Loosen V-band (72020) and remove silencer or air suction branch.



S_00103

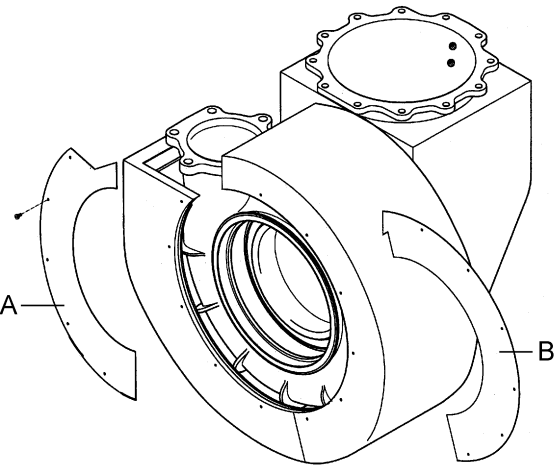
1	Silencer	2	Air suction branch
---	----------	---	--------------------

- Slightly loosen screws (72011) and turn compressor casing (72000), until the ring bolt (90230) on the lifting equipment can be secured.



S_00114

If provided



S_00105



NOTE

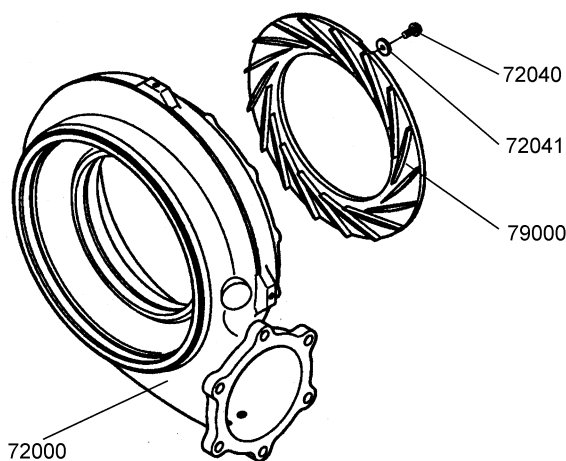
If the compressor casing can not be easily released, it can be pushed off against the turbine casing with the press-off tool (90042). For this, the two cover plates (A+B) of the turbine casing insulation must be removed.

**CAUTION****Axial force**

A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

- ▶ Therefore always engage at both sides alternately and do not press off too much at each side.

- ▶ Loosen screws (72011) and remove with securing straps (72012).
- ▶ Carefully travel compressor casing (72000) away horizontally with wall insert (77000).

Diffusor disassembly
TPS..-F31/F32
*S_00115*

- ▶ Release screws (72040) and remove from compressor casing (72000) with fixing washers (72041) and diffuser (79000).
- ▶ Knock wall insert (77000) out of the compressor casing with nylon hammer and remove O-ring gasket (77005).

TPS 61

To lift the wall insert (77000) use the ring bolts (90255).

Installing compressor casing

Diffusor assembly TPS.. –
F31/F32

- ▶ Install wall insert (77000) and O-ring gasket (77005) analogously in the reverse order.
- ▶ Install diffuser analogously in the reverse order.
- ▶ Fit the compressor casing analogously in the reverse order.



NOTE

Always replace O-ring gaskets. (see section **Spare parts**)

- ▶ Thoroughly clean securing straps (72012) and V-band (72020) before assembly. Grease V-band thread and inside of the profile with Antiscuff (or similar high-temperature lubricating paste).



CAUTION

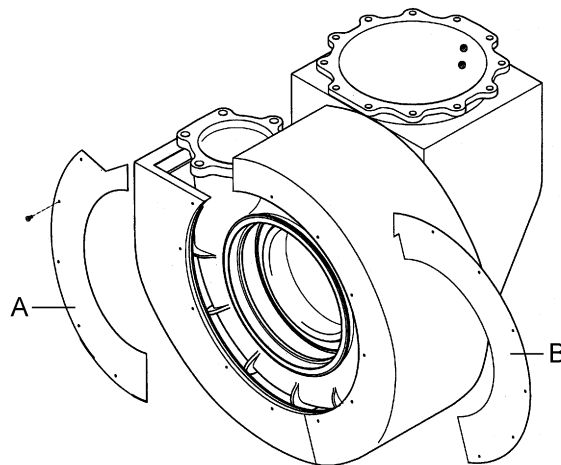
Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

Removing cartridge group

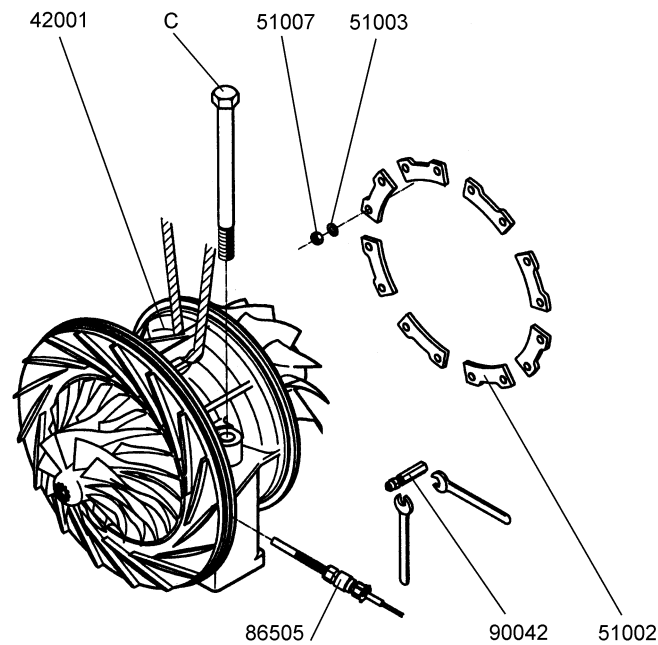
- ▶ Check lifting equipment and secure to bearing casing (42001).

If provided

- ▶ Disconnect all lines according to engine manufacturer's specifications, remove insulation, dismantle turbocharger and remove compressor casing as well as filter silencer (see also previous chapter).

*S_00105*

- ▶ Remove screws on both plates (A+B) of the turbine casing insulation and remove the plates.



S_00117

If provided

- ▶ Disconnect plug to speed measuring transmitter (86505)
- ▶ Treat screw thread of the studs (51006) with creep oil and allow to react.
- ▶ Release nuts (51007) and remove Verbus washers (51003) with securing straps (51002).
- ▶ Loosen fastening screws (C) of the bearing casing (42001) and remove.
- ▶ Remove cartridge group.
- ▷ Bearing casing is not easy to remove.

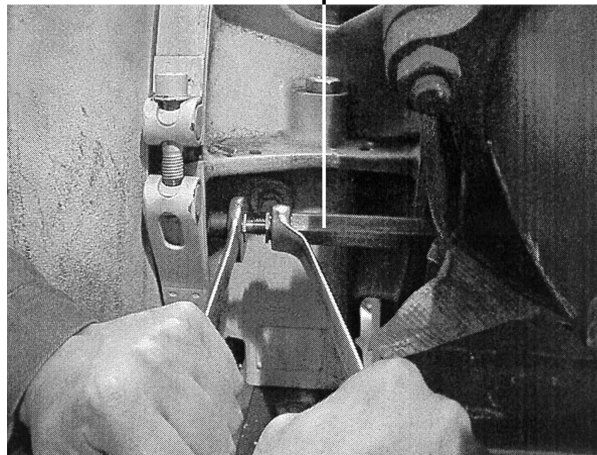
- Press off bearing casing with press-off tool (90042) against the turbine casing (see following diagram)

**Axial force**

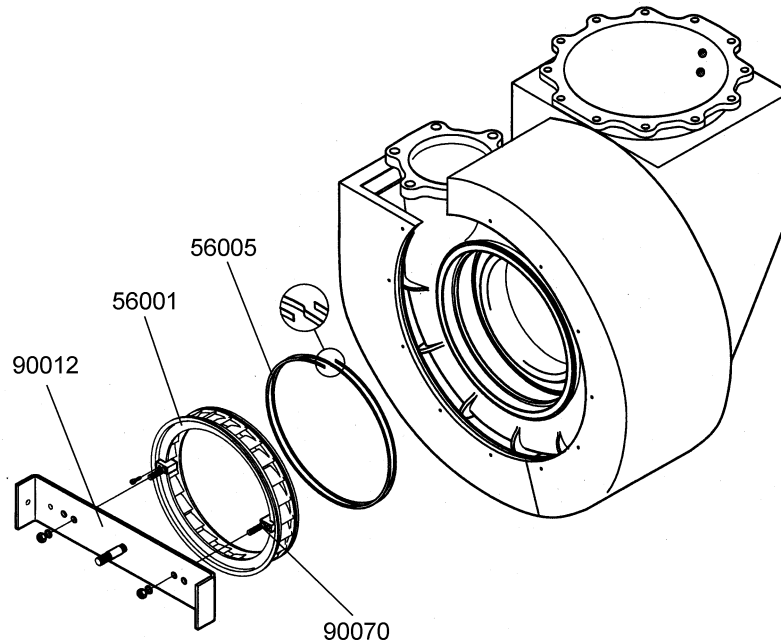
A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

- Therefore always engage at both sides alternately and do not press off too much at each side.

90042

*S_00128*

- Cover oil connections.



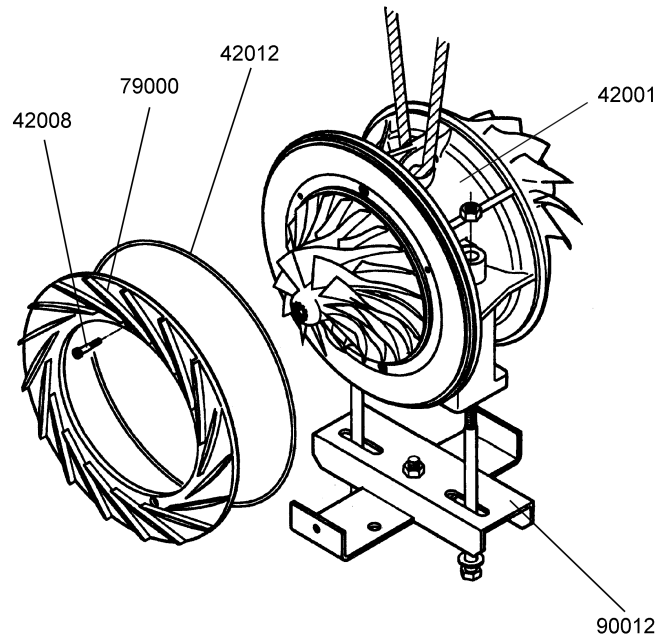
S_00107

- Withdraw nozzle ring (56001) with the two withdrawal devices (90070) and the service support bracket (90012).

If provided

- Remove lamellar sealing ring (56005).

Diffusor disassembly
TPS.. D/E/F33

*S_00110*

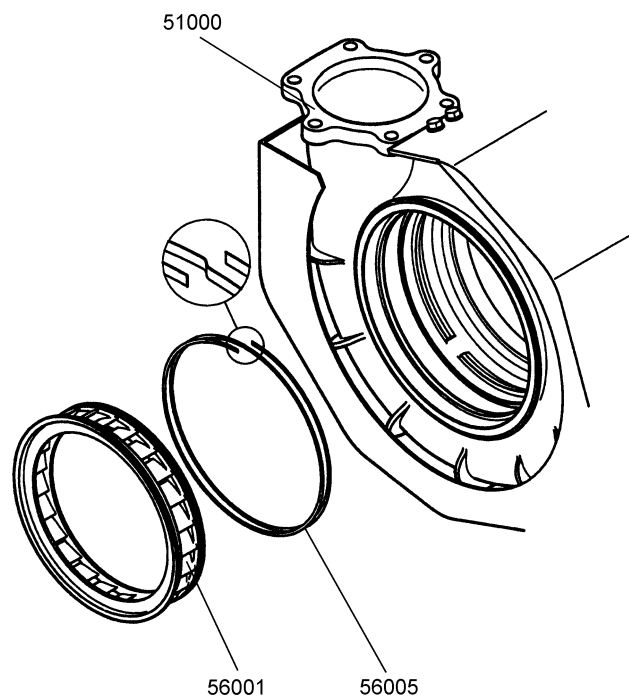
- ▶ Place cartridge group on the service support (90012) and screw tight.
- ▶ Loosen screw (42008) and remove diffuser (79000) and O-ring gasket (42012).
- ▶ Measure axial and radial clearances (see section **Axial and Radial Clearances**).

Installing the cartridge group



NOTE

Always replace O-ring gaskets (see section **Spare parts**)



S_00109

If provided

- ▶ Fit lamellar sealing ring (56005).



NOTE

Ensure the correct coiling of the lamellar sealing ring (56005).

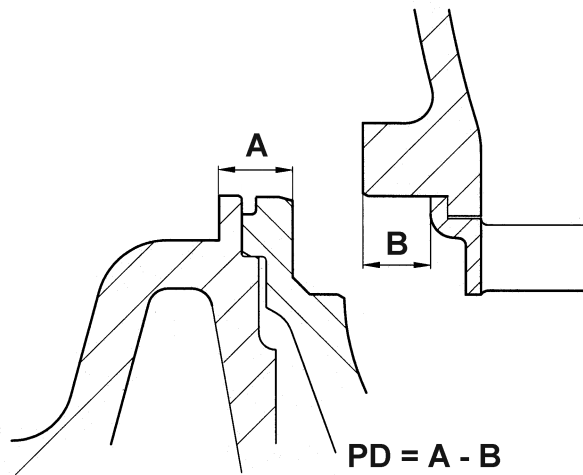
- ▶ Push in nozzle ring (56001) up to the stop in the turbine casing (51000).
- ▶ Pay attention to the position of the cam.



NOTE

So that the nozzle ring is fixed during operation, it must be clamped between the partition wall and the turbine casing.

- The pressing (PD) must be calculated.



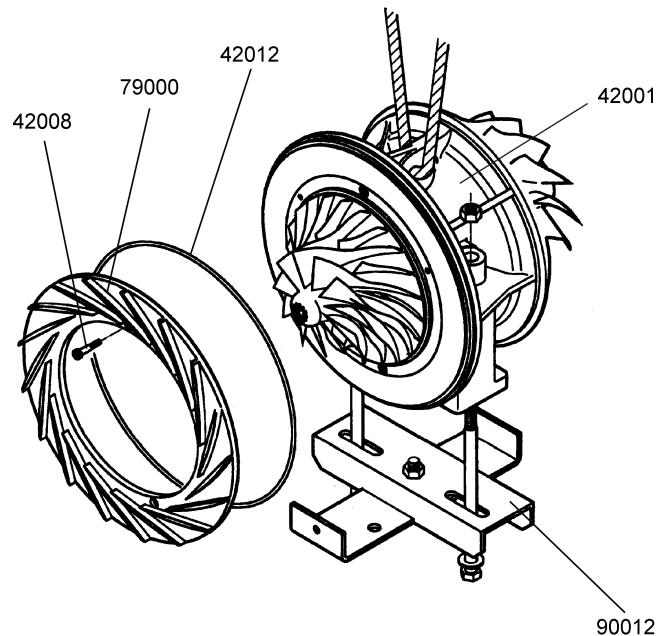
S_00133



NOTE

If the calculated value (PD) is less than **0.1 mm**, an official service station of ABB Turbo Systems must be contacted.

- Measure axial and radial clearances (see section **Axial and Radial Clearances**).

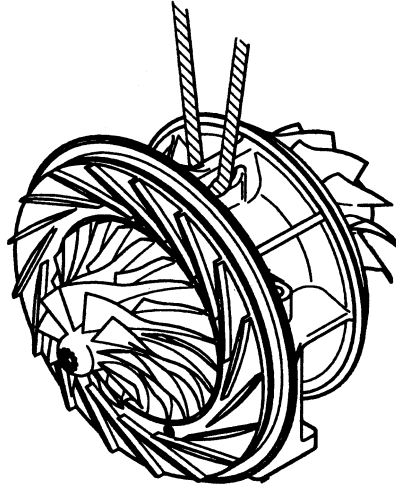
**Diffusor assembly
TPS...D/E/F33***S_00110*

- ▶ Secure diffuser (79000) and O-ring gasket (42012) with screw (42008).

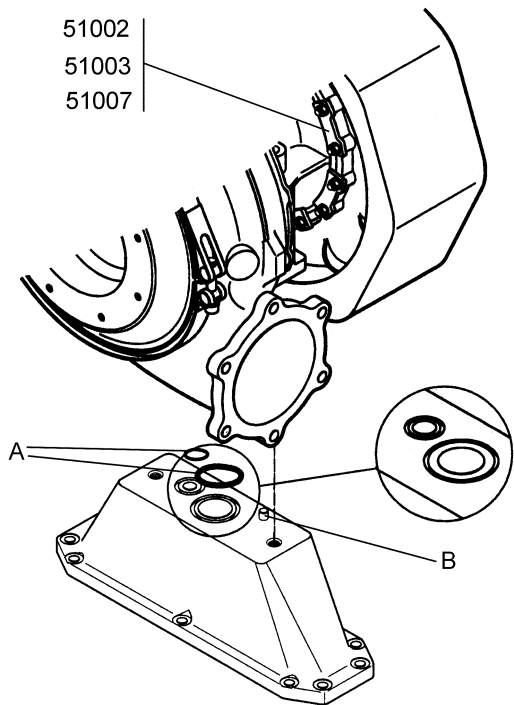
**NOTE**

See section Removing Rotor.

- ▶ Check lifting equipment and secure to bearing casing (42001).
- ▶ Unscrew cartridge group and lift from the service support (90012).
- ▶ Grease centering seats and screw threads with Antiscuff (or similar high-temperature lubricating paste).
- ▶ Remove provisional covers at the oil connections.

*S_00134*

- Fit cartridge group as far as possible by hand



S_00118



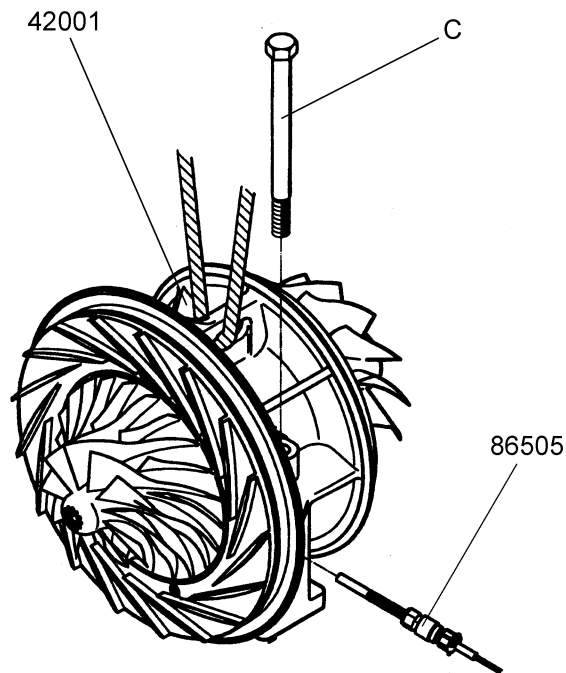
CAUTION

During assembly of the cartridge group, do not damage or move gasket rings (A) in the securing support. The gasket rings (A) are engine side and are not included in the scope of supply of ABB Turbo Systems.



NOTE

If two turbochargers, each with a left and right oil inlet, are mounted on one engine, as a precaution against mistaken, incorrect assembly, a pin can be fitted in the bracket as assembly security device. This pin (B) fits in the respective groove on the foot of the bearing casing.

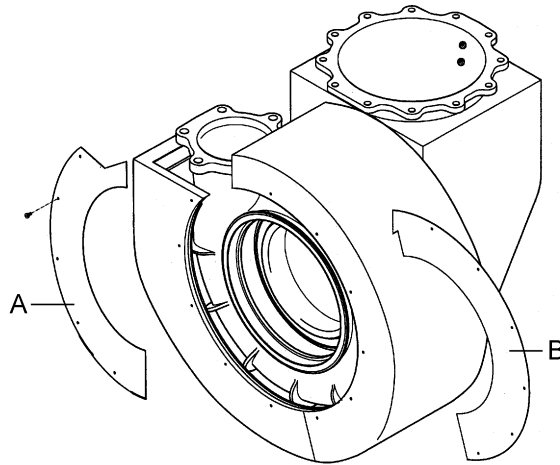


S_00113

- ▶ Secure cartridge group with the securing straps (51002), the Verbus washers (51003) and nuts (51007) (see also chapter Tightening torques table).
- ▶ Secure bearing casing (42001) with fixing screws (C).
- ▶ Tighten fixing screws (C) with the tightening torques according to the following table.

TPS	Fixing screws C [mm]	Tightening torques [Nm]
48	M16	230
52	M20	455
57	M20	455
61	M24	780

If provided



S_00105

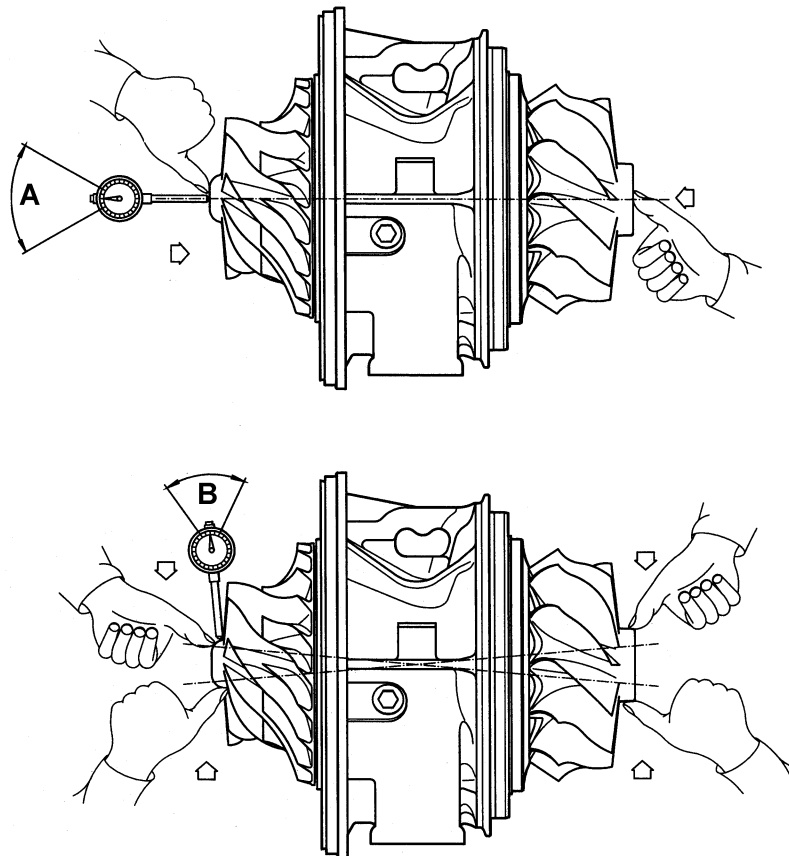
- Plug in connector for speed measuring transmitter (86505) and fit the insulation plates (A/B).



CAUTION

Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

8.4 Axial and radial clearances



S_00119

- After removal and before the installation of the cartridge group, the axial clearance **A** and the radial clearance **B** are to be measured and noted.



NOTE

To correctly measure the axial clearance **A**, raise the turbine slightly.

Axial and radial clearance
[mm]

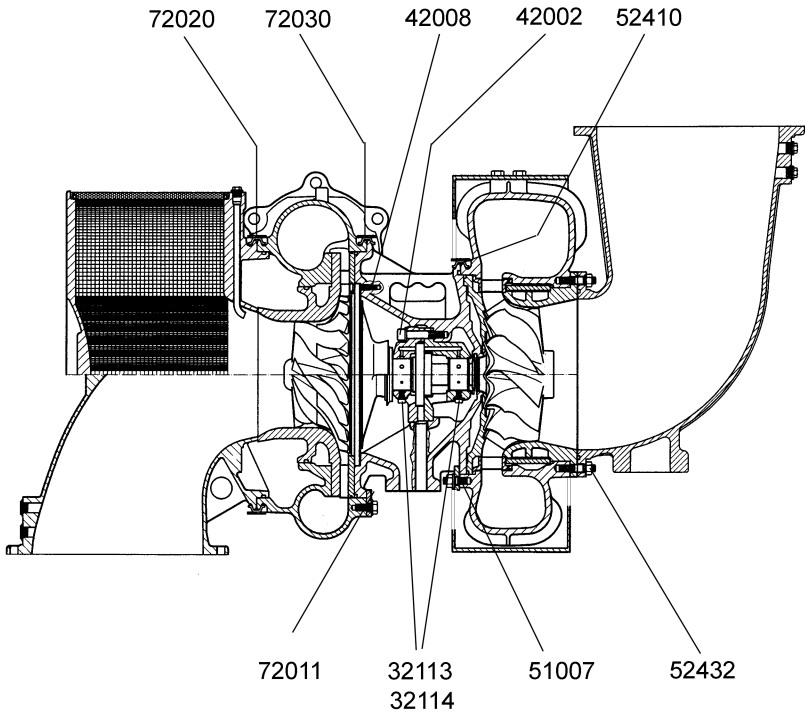
	TPS 48	TPS 52	TPS 57	TPS 61
A at least	0.08	0.10	0.12	0.15
A maximum	0.16	0.18	0.21	0.25
B at least	0.50	0.61	0.72	0.81
B maximum	0.99	1.15	1.31	1.55



CAUTION

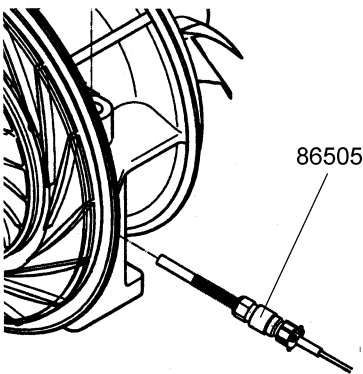
If the clearances are outside the tolerance, an official ABB Turbo Systems service station must be contacted.

8.5 Table of tightening torques



S_00120

If provided



S_00121

The tightening torques listed must be observed for the screwed connections listed in the following table.

Tightening torques [Nm]

Part no.	TPS 48	TPS 52	TPS 57	TPS 61
32113	10	10	20	40
32114	10	10	20	40
42002	20	40	65	65
42008	10	10	20	40
51007	25	45	75	75
52410	60 ¹⁾	60 ¹⁾	60 ¹⁾	-
52432	20	40	65	65
72011	35	70	105	105
72020	60	60	60	60
72030	60 ¹⁾	60 ¹⁾	-	-
86505	15	15	15	15

¹⁾ V-band connection only

9 Taking out of operation

9.1 Turbocharger shut down (with V-band connection)

If with a damaged turbocharger, the Diesel engine can only be shut down temporarily for an emergency repair, then the following procedure should be adopted:

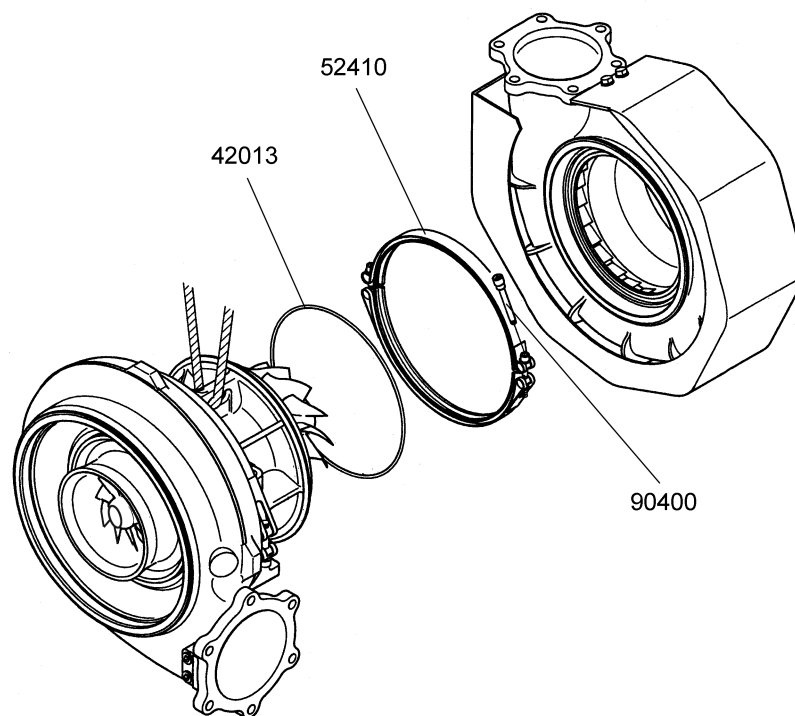
- Fit cover plate.



CAUTION

The instructions of the engine manufacturer for operation of the engine with locked / isolated turbocharger must be followed precisely in all cases!

Fitting the cover plate

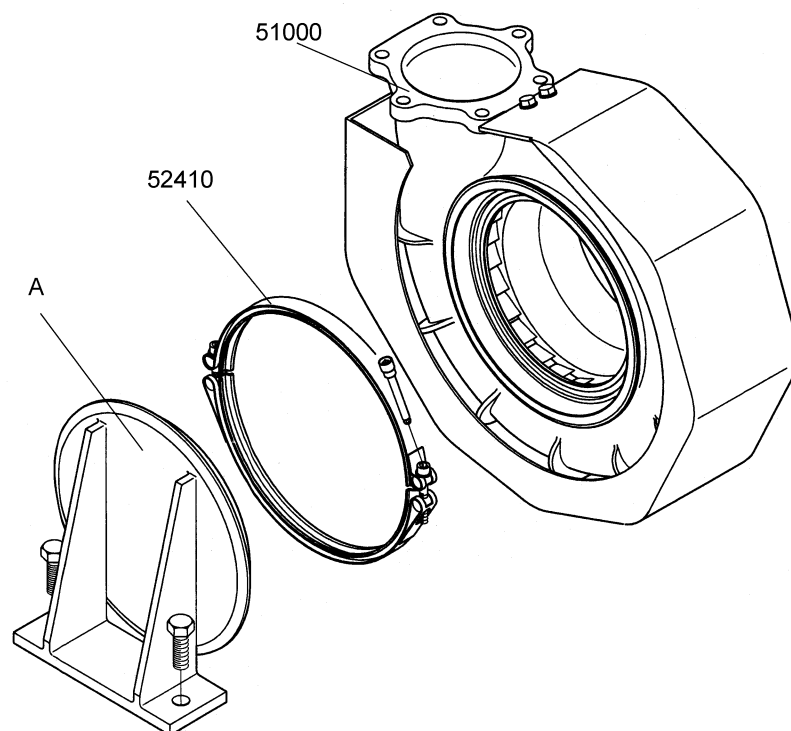


S_00122

- Dismantle turbocharger. (See section **Disassembling and assembling turbocharger with V-band connection**)

**NOTE**

Do not disassemble nozzle ring.



S_00123

- Block the opening in the turbine casing with the cover plate (A).
- Secure cover plate to turbine casing (51000) with V-band (52410) and screw tight on support.

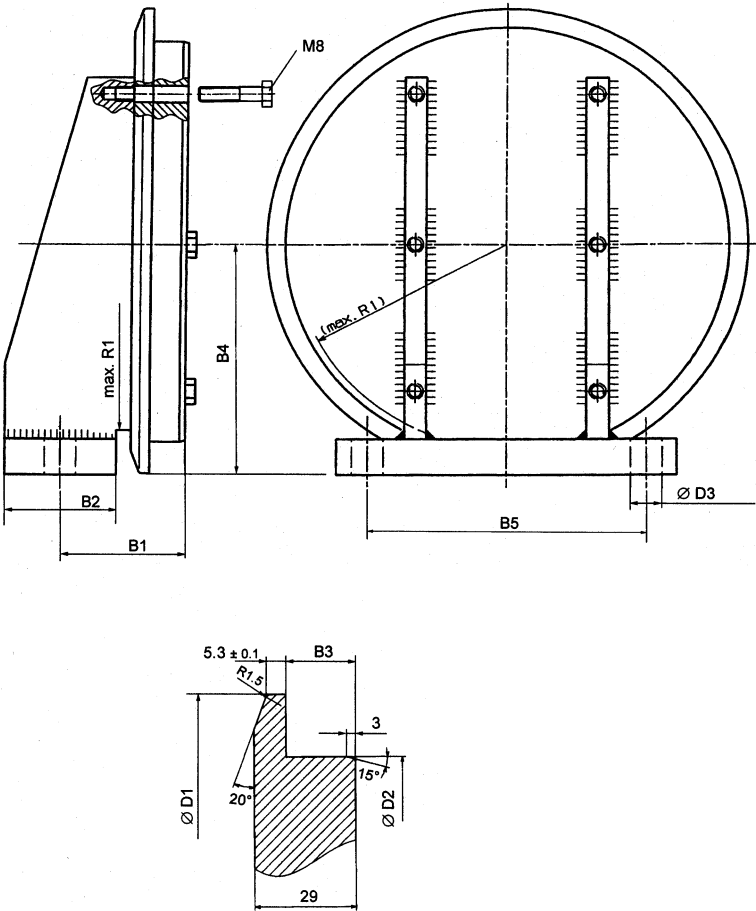
**NOTE**

Clean V-band (52410) thoroughly with a steel brush before assembly. Grease thread and inside of the profile with Antiscuff (or similar high-temperature lubricating paste).

Cover plate drawing



The cover plate (material: general structural steel, in accordance with DIN EN 10025-2) must be produced in-house according to the drawing.



S_00124

Cover plate with V-band connection

TPS	B1 [mm]	B2 [mm]	B3 [mm]	B4 [mm]
48	65.7 ± 0.4	60	19.1 ± 0.1	130
52	79.6 ± 0.4	78	20.1 ± 0.1	155

Taking out of operation	9
-------------------------	---

Turbocharger shut down (with V-band connection)	9.1	Page 4
---	-----	--------

TPS	B5 [mm]	ØD1 [mm]	ØD2 [mm]	ØD3 [mm]	R1 [mm]
48	150	258 ± 0.2	222.7 ± 0.2	17	115
52	180	307 ± 0.2	265.7 ± 0.2	21	135

September 2005

HZTL2410_EN (TPS48-61)

Version 2

9.2 Turbocharger shut down (with strap connection)

If with a damaged turbocharger, the Diesel engine can only be shut down temporarily for an emergency repair, then the following procedure should be adopted:

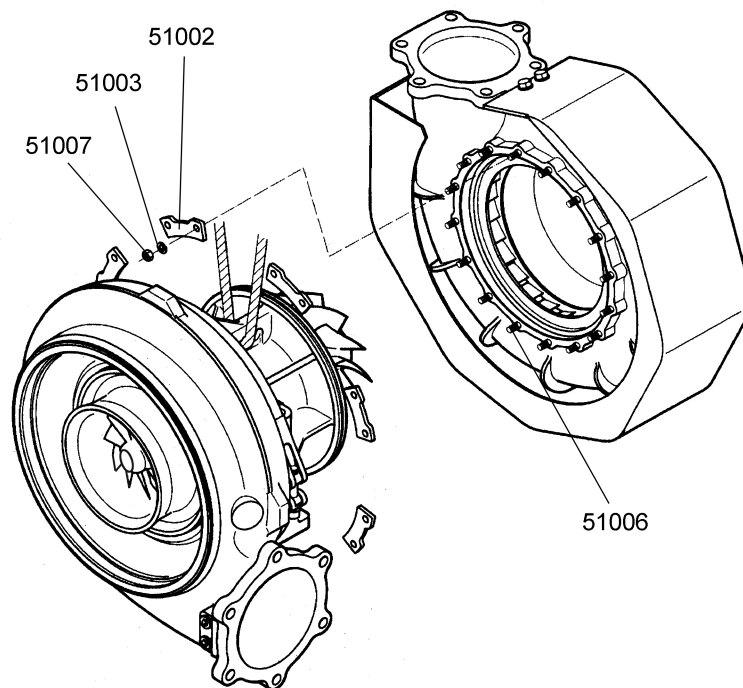
- Fit cover plate.



CAUTION

The instructions of the engine manufacturer for operation of the engine with locked / isolated turbocharger must be followed precisely in all cases!

Fitting the cover plate



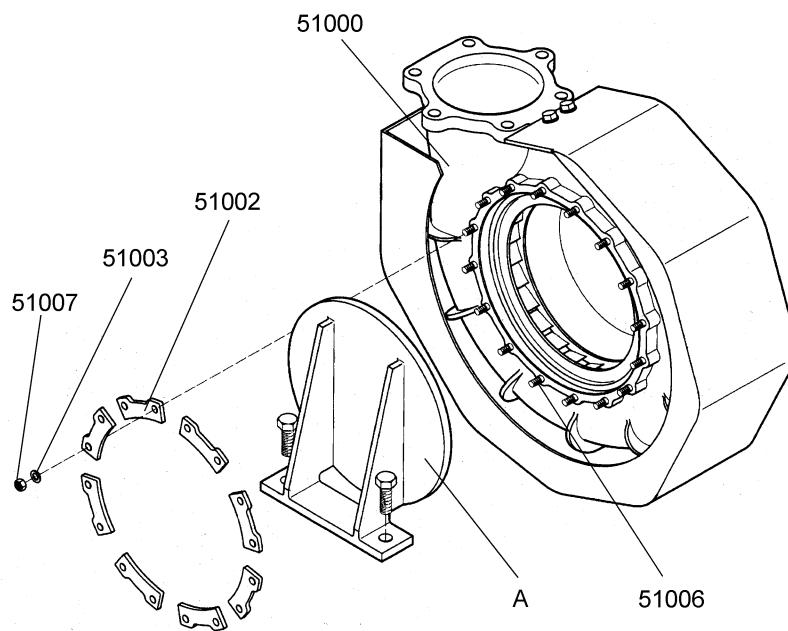
S_00125

- Turbocharger disassembly (see section **Disassembling and assembling turbocharger with strap connection**).



NOTE

Do not disassemble nozzle ring.



S_00126

- ▶ Block the opening in the turbine casing with the cover plate (A).
- ▶ Secure cover plate to the turbine casing (51000) with securing straps (51002), Verbus washers (51003) and nuts (51007) and screw tight on support.



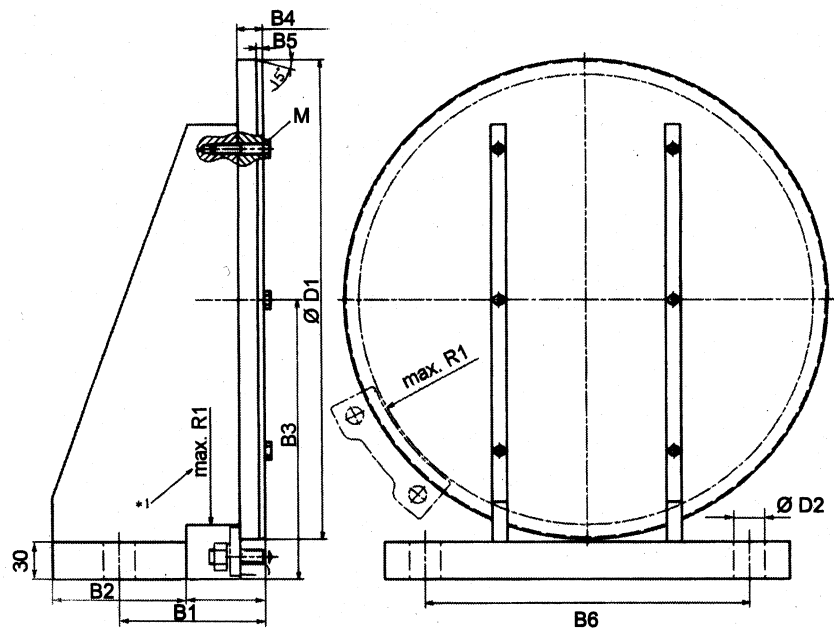
NOTE

Clean securing straps (51002) thoroughly before assembly. Grease thread of studs (51006) with Antiscuff (or similar high-temperature lubricating paste).

Cover plate drawing



The cover plate (material: general structural steel, in accordance with DIN EN 10025-2) must be produced in-house according to the drawing.



S_00127

Cover plate with strap connection

TPS	B1 [mm]	B2 [mm]	B3 [mm]	B4 [mm]	B5 [mm]
48	65.7 ± 0.5	60	130	11.7 ± 0.2	1.5
52	79.6 ± 0.5	78	155	14.2 ± 0.2	1.5
57	98.2 ± 0.5	100	190	17.2 ± 0.2	2
61	116.8 ± 0.5	120	226	20.5 ± 0.2	2.4

Taking out of operation	9
-------------------------	---

Turbocharger shut down (with strap connection)	9.2	Page 8
--	-----	--------

TPS	B6 [mm]	ØD1 [mm]	ØD2 [mm]	R1 [mm]	M
48	150	222.7 ± 0.2	17	maximum 150	M8
52	180	265.7 ± 0.2	21	maximum 125	M8
57	220	325.7 ± 0.2	21	maximum 153	M10
61	260	387.7 ± 0.2	25	maximum 182	M10

September 2005

HZTL2410_EN (TPS48-61)

Version 2

10 Mothballing the turbocharger

10.1 Taking out of operation for up to 12 months

If a turbocharger has to be laid up for up to 12 months, the decision whether the turbocharger needs special protection or not depends mainly on the condition of the lubricating oil before laying up.

If the Total Acid Number (TAN) is lower than 2 mg KOH/g no special measures need to be taken. However, if the neutralisation factor is higher the turbocharger must be dismantled after laying up, cleaned and protective oil must be applied to the naked parts.

If the turbocharger is left mounted on the engine, and the engine oil is replaced by a protective oil which is circulated with a pre-lubrication pump prior to laying up, no measures need to be taken in respect of the turbocharger. The remains of the old engine oil will be washed away and the sensitive bearing parts will be largely protected against corrosion.

If the rotor turns due to a draught from the flue, fit a blind flange between the compressor casing and the charge-air duct.

10.2 Taking out of operation for more than 12 months

If the turbocharger has to be removed from the engine and stored for a prolonged period of time, disassembly and mothballing of the turbocharger must be done by an official ABB Turbo Systems service station.

Ensure that the area where the turbocharger is to be stored is dry with humidity of 40-70% and free of condensation.



NOTE

Check mothballed turbochargers yearly for corrosion.

In the event of rust, clean and renew the corrosion protection.

11 Reserve and spare parts

11.1 Ordering spare parts

When making inquiries or ordering spare parts, the following data should be specified:

- Turbocharger type
- HT number
- Description and part number

Our service stations and agents accept orders for spare parts.

- If special variants/cases are not addressed in these general instructions, contact an official ABB Turbo Systems Ltd. service station or an ABB agent.

Spare-parts set



NOTE

Spare-parts set (97070) is required for the work described in this manual. The parts included in the spare-parts set are only available as part of the complete set.

Spare parts set (97070)

Quantity	Description	Part number
1	Socket head screw	42008
2	O-ring gasket	42012/ 81010/ 82010
1	O-ring gasket	77005
1 ¹⁾	Gasket	42013
1	Gasket	52406
1 ¹⁾	V-Band	52410

¹⁾ Only TPS with bearing casings with V-band connection

Reserve and spare parts	11
-------------------------	----

Ordering spare parts	11.1	Page 2
----------------------	------	--------



CAUTION

All spare parts that have been ordered with the turbocharger should be kept complete and serviceable.

- ▶ Rusty parts should be carefully cleaned and greased.

- ▶ Dispose of parts that have been exchanged and are no longer usable in a technically and environmentally compatible manner.

11.2 Directory of part numbers

The following part numbers and descriptions must be used in ALL correspondence or orders:

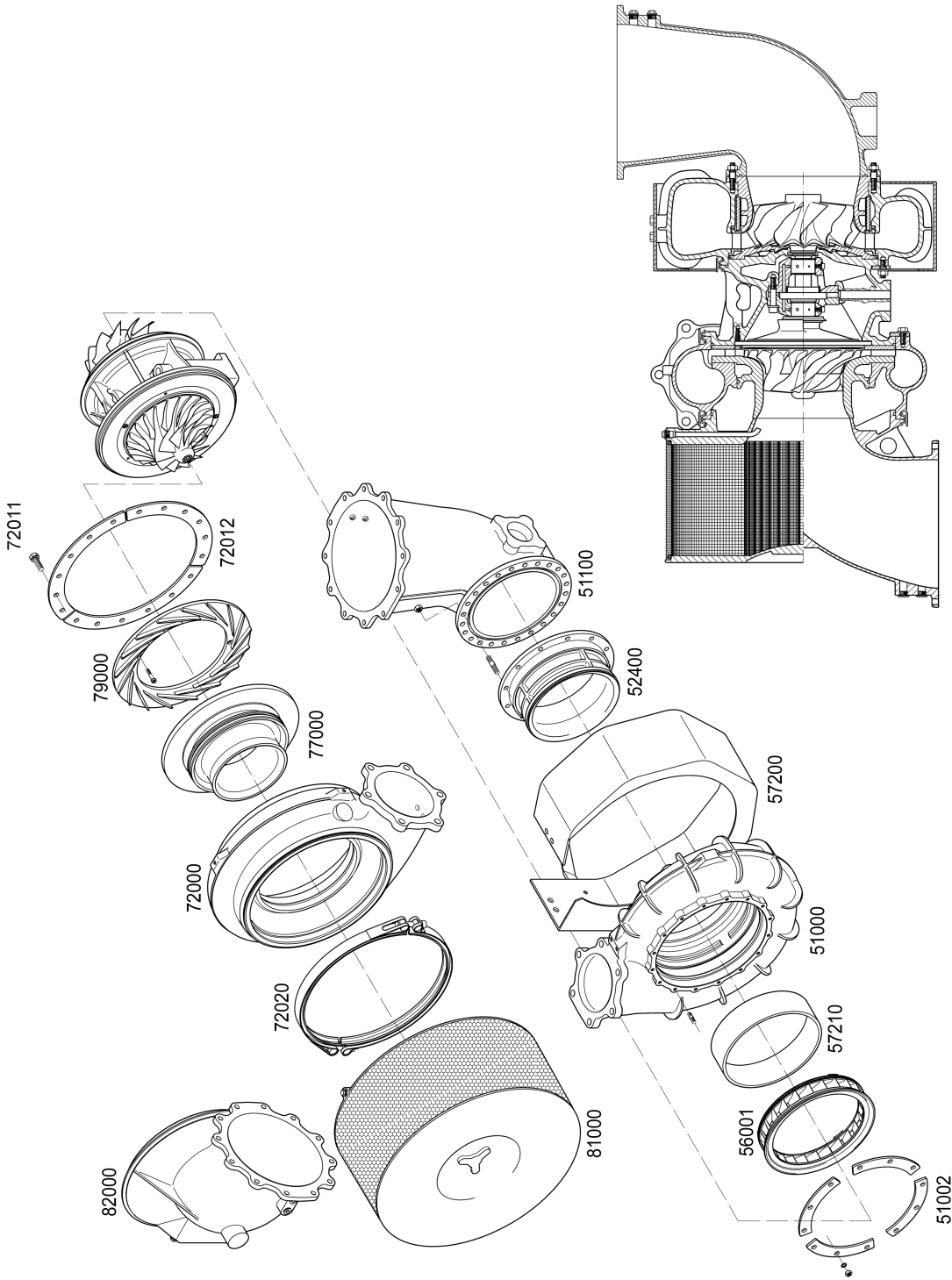
Turbocharger

Part no.	Description
51000	Turbine casing
51002	Securing straps
51100	Gas outlet manifold
52400	Gas outlet flange
56001	Nozzle ring
57200	Rupture protection
57210	Rupture ring
72000	Compressor casing
72011	Socket head screw
72012	Securing straps
72020	V-Band
77000	Wall insert
79000	Diffuser
81000	Filter silencer
82000	Air suction branch, axial

Cartridge group

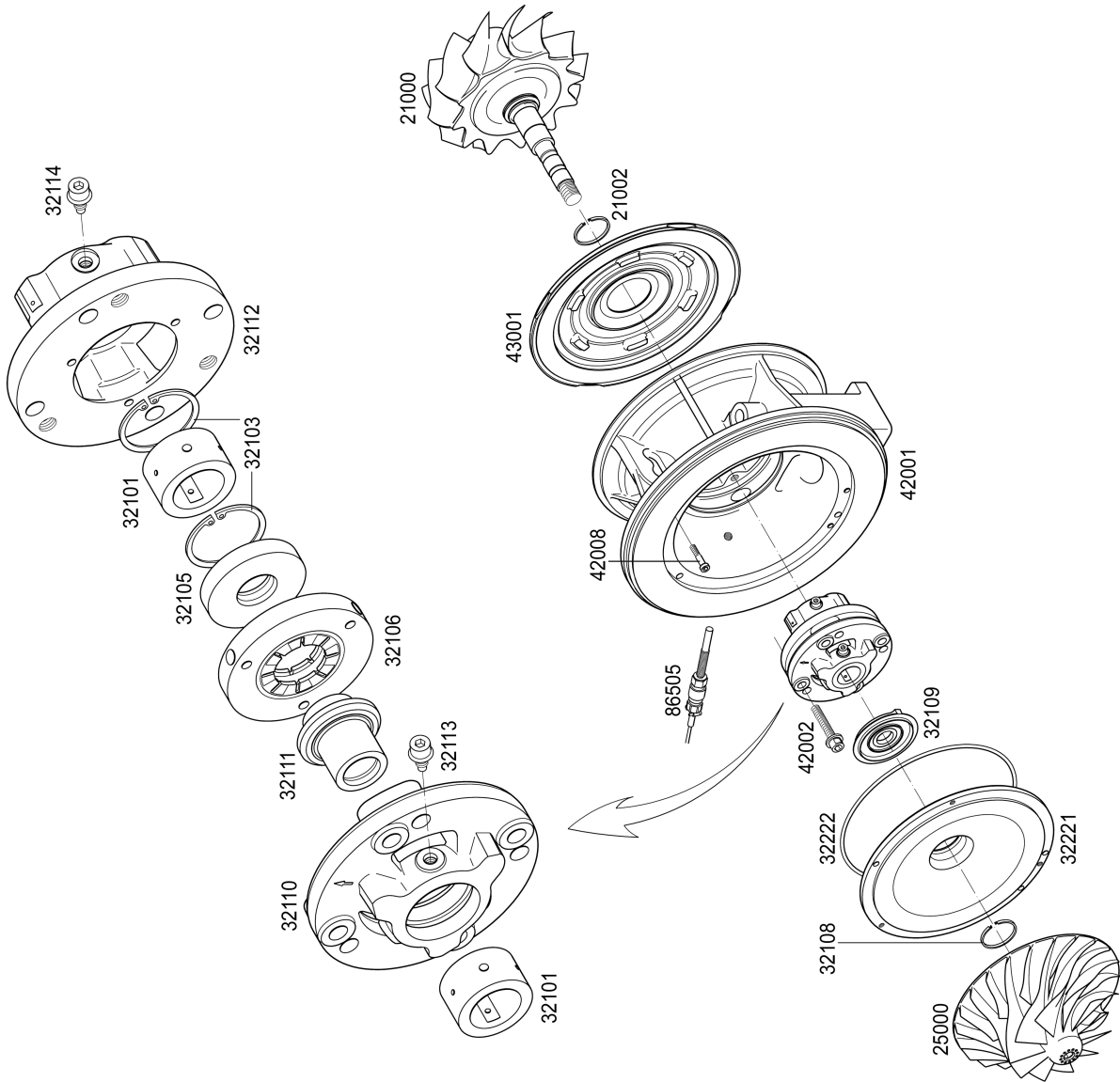
Part no.	Description
21000	Shaft
21002	Piston ring
25000	Compressor wheel
32101	Plain bearing bush
32103	Seeger circlip
32105	Thrust ring
32106	Thrust bearing
32108	Piston ring
32109	Sealing disc
32110	Compressor-end bearing flange
32111	Auxiliary bearing
32112	Turbine-end bearing flange
32113	Socket head screw
32114	Socket head screw
32221	Bearing cap
32222	O-ring gasket
42001	Bearing casing
42002	Socket head screw
42008	Socket head screws
43001	Interior wall

11.3 General view of turbocharger



S_00130

11.4 General view of cartridge group



S_00131



ABB Turbo Systems AG
Bruggerstrasse 71a
CH-5400 Baden
Switzerland



Installation and Operation Manual



UG-25⁺ Governor

Manual 26330

WARNING—DANGER OF DEATH OR PERSONAL INJURY



WARNING—FOLLOW INSTRUCTIONS

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.



WARNING—OUT-OF-DATE PUBLICATION

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the Woodward website:

www.woodward.com/pubs/current.pdf

The revision level is shown at the bottom of the front cover after the publication number. The latest version of most publications is available at:

www.woodward.com/publications

If your publication is not there, please contact your customer service representative to get the latest copy.



WARNING—OVERSPEED PROTECTION

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.



WARNING—PROPER USE

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY



CAUTION—BATTERY CHARGING

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.



CAUTION—ELECTROSTATIC DISCHARGE

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

IMPORTANT DEFINITIONS

- A **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
- A **CAUTION** indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment or property.
- A **NOTE** provides other helpful information that does not fall under the warning or caution categories.

Woodward Governor Company reserves the right to update any portion of this publication at any time. Information provided by Woodward Governor Company is believed to be correct and reliable. However, no responsibility is assumed by Woodward Governor Company unless otherwise expressly undertaken.

© Woodward 2006
All Rights Reserved

Contents

REGULATORY COMPLIANCE.....	IV
ELECTROSTATIC DISCHARGE AWARENESS	V
CHAPTER 1. GENERAL INFORMATION.....	1
Purpose and Scope	1
How to Use This Manual	1
Description.....	1
Controller Features.....	2
Inputs / Outputs	2
Available Terminal Shafts and Drive Shafts	2
UG-Governor Similarities	3
Hydraulic Pump	3
References	3
Serviceability	3
CHAPTER 2. INSTALLATION PROCEDURE.....	5
Introduction	5
Initial Operation	5
Unpacking.....	6
Drive Shaft Rotation	8
Mounting Location	8
Drive Connection	9
Control Linkage	9
Oil Supply	11
Electrical Connection.....	14
Heat Exchanger.....	14
CHAPTER 3. UG-25⁺ ELECTRICAL INSTALLATION	15
Introduction	15
Unit Grounding	15
Shielded Wiring	16
Electrical Connections	17
Customer I/O Pin Assignment (30-Pin Connector)	20
Detailed Description of UG-25 ⁺ Electrical I/O.....	23
CHAPTER 4. DESCRIPTION OF OPERATION	26
General.....	26
Principal of Operation	27
Speed Governor Features Description.....	29
Starting the Engine	30
Speed Control Functions.....	31
Speed Setting Functions	32
Speed Control Dynamics.....	34
Fuel Limiting	35
Temperature Sensing	38
Current Limiting based on Temperature	39
Control Modes	39
Fault Detection and Annunciation	40
Alarms.....	40
Shutdowns	41
CHAPTER 5. SERVICE TOOL	42
Introduction.....	42
Description.....	42
Getting Started	44

Contents

CHAPTER 6. CONFIGURATION	51
Overview	51
Configuring the Unit—On-Line	51
Configuring the Unit—Off-Line	52
Application File Data	52
Configuration Parameters	53
Overview Tab	53
Speed Input Configuration Settings	53
Starting the Engine	55
Set Point Tab	57
Fuel Limiting Tab	58
Dynamics Tab	59
Security Tab	61
Configuration Checks	63
CHAPTER 7. SPEED PID TUNING	64
Introduction	64
Adjusting Trend Settings	65
Speed PID Dynamic Settings	66
Speed Set Point Adjustments	68
Front-panel Stability Pot	69
CHAPTER 8. TROUBLESHOOTING	70
Introduction	70
General System Troubleshooting Guide	71
Engine/Generator Troubleshooting	72
Troubleshooting Alarm and Shutdown Faults	76
Electrical Troubleshooting Guide	78
CHAPTER 9. SERVICE OPTIONS	80
Product Service Options	80
Returning Equipment for Repair	81
Replacement Parts	82
How to Contact Woodward	82
Engineering Services	83
Technical Assistance	84
APPENDIX A. ACRONYMS / ABBREVIATIONS	85
APPENDIX B. UG-25⁺ CONTROL SPECIFICATIONS	86
I/O Specifications	87
Transfer Function	89
UG-25⁺ CONFIGURATION SUMMARY	90
DECLARATIONS	91

Illustrations and Tables

Figure 1-1. UG-25 ⁺ Outline Drawing	4
Figure 2-1 UG-25 ⁺ Governor Overview	7
Figure 2-2. Terminal Shaft Travel.....	10
Figure 2-3. Linear Linkage	10
Figure 2-4. Non-linear Linkage.....	10
Figure 2-5. Oil Chart.....	12
Figure 2-6. Viscosity Comparisons	13
Figure 3-1a. UG-25 ⁺ Application Wiring	18
Figure 3-1b. UG-25 ⁺ Connector Pin Arrangement as Viewed from Top	19
Figure 3-2. Connector Wiring Assembly	19
Figure 3-3. Internal Block Diagram.....	23
Figure 3-4. Correct and Incorrect Wiring to Power Supply	24
Figure 3-5. Relay Driver Output	24
Figure 4-1. UG-25 ⁺ Overview	26
Figure 4-2. Governor Functional Overview	28
Figure 4-3. Governor Functional Overview	30
Figure 4-4. 5% Droop Example	33
Figure 4-5. Dual Gain Settings	35
Figure 4-6. Single Start Fuel Limit.....	36
Figure 4-7. Dual Start Fuel Limiters	36
Figure 4-8. Boost (External) Fuel Limit Curve.....	37
Figure 4-9. Jump Rate Limiter.....	38
Figure 5-1. Example Service Tool Screen	42
Figure 5-2a. Programming Harness Connection	43
Figure 5-2b. Typical Programming Datalink Harness Wiring	44
Figure 5-3. Service Tool – Overview Tab.....	46
Figure 5-4. Service Tool – Alarms Tab	48
Figure 5-5. Service Tool – Shutdowns Tab.....	49
Figure 5-6. Service Tool – Internal Shutdowns Tab.....	49
Figure 5-7. Service Tool – Simulated I/O Tab.....	50
Figure 5-8. Service Tool – Identification Tab	50
Figure 6-1. Configuration Selection Options	52
Figure 6-2. Configuration Editor – OVERVIEW TAB.....	53
Figure 6-3. Configuration Editor– SETPOINT TAB	57
Figure 6-4. Configuration Editor– Fuel Limiting Tab	58
Figure 6-5. Configuration Editor–Dynamics Tab	59
Figure 6-6. Configuration Editor– Security Tab.....	61
Figure 6-7. Security tab Set Password Pop-up	62
Figure 6-8. Password Entry Prompt	62
Figure 6-9. Direct Load of Configuration File	63
Figure 7-1a. Service Tool – Speed Dynamics Position Curve	65
Figure 7-1b. Service Tool – Speed Dynamics Single Gain.....	65
Figure 7-2. Service Tool – PID Tuning Properties Window	66
Figure 7-3. Speed Set Point Adjustment	68
Figure 7-4. Actual PID Dynamics on Overview Tab.....	69

Regulatory Compliance

The L-Series UG-25⁺ is suitable for use in Class I, Division 2, Groups A, B, C, D per CSA for Canada and U.S.

Wiring must be in accordance with North American Class I, Division 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field wiring must be suitable for at least 105 °C.

The module housing should be protected from exposure to sunlight and rain.

These listings are limited only to those units bearing the CSA agency identification.

**WARNING—EXPLOSION HAZARD**

Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

**AVERTISSEMENT—RISQUE D'EXPLOSION**

Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division ou Zone.

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).
2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.
4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
 - Do not touch any part of the PCB except the edges.
 - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
 - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.



CAUTION—ELECTROSTATIC DISCHARGE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Chapter 1.

General Information

Purpose and Scope

The purpose of this manual is to provide the necessary background information for applying the UG-25⁺, used on reciprocating engines. Topics covered include mechanical installation and electrical wiring. While this manual is primarily targeted at OEM customers, OEMs themselves may find it useful to copy some of the information from this manual into their application user manuals.

How to Use This Manual

The following summarizes how to install a UG-25⁺ into a new or existing system:

- Unpack and inspect the hardware.
- Mount and wire the hardware following the procedures and recommendations in Chapters 2–3.
- Configure application-specific settings (Chapter 6).
- Speed control tuning information is found in Chapter 7.
- Specifications and Troubleshooting information are provided in the Appendixes.

Description

The Woodward UG-25⁺ Governor is a microprocessor controlled mechanical hydraulic governor for controlling diesel, gas, or dual fuel engines, or steam turbines. The UG-25⁺ includes enhanced control capabilities, such as start fuel and boost limiting schemes. The additional transient fuel limiting (jump-rate) improves the engine load acceptance and reduces transient emissions significantly.

The UG-25⁺ provides a fast-acting and high-work-output governor, without the need for any auxiliary devices such as a start booster.

The UG-25⁺ offers speed control with software-selectable speed set points, dynamics, fuel limiting, and start behavior. The UG-25⁺ offers speed control with software-selectable speed set points, dynamics, fuel limiting, and start/stop behavior.

Front panel and external speed settings make synchronization easy for generator applications. A 4–20 mA speed setting is available for variable speed applications or for remote synchronization or remote setting of speed/load.

Adjustable droop permits load division and balancing among parallel prime movers. Droop can be set with a knob on the front panel between 0–10%. The load limiter knob allows you to limit the governor output manually.

The UG-25⁺ uses a 1034 kPa (150 psi) internal operating pressure with an internal oil pump driven from the governor's drive shaft. Oil pressure is maintained by a relief valve system with a drain to an internal oil sump.

The UG-25⁺ combines all the advantages of a traditional mechanical governor with the state-of-the-art control algorithms for optimal engine operation.

Controller Features

The governor features include:

- State-of-the-art speed sensing and control algorithms
- Built-in user interface which provides speed raise/lower and emergency stop functions
- Speed Control with Droop and Dynamics features
- Configurable speed settings and adjustment rates
- Multiple Fuel Limiting algorithms, such as jump-rate, boost pressure, and start fuel limiting
- Temperature monitoring
- Run / Stop
- Status discrete output
- Speed set point adjustments using a 4–20 mA analog input or raise/lower discrete inputs or front panel raise/lower commands
- Front panel Droop, Stability, and Load Limit adjustments are also available
- Comprehensive diagnostics for easy troubleshooting

Inputs / Outputs

The following optional inputs and outputs are available, only input power is required.

- Input Power (single or dual)
- Run/Stop discrete input
- Unit Health Status discrete output
- Speed Set Point Raise discrete input
- Speed Set Point Lower discrete input
- Analog Speed Set Point 4–20 mA input
- Analog Speed Set Point Enable discrete input
- Boost Pressure 4–20 mA input
- Boost Pressure Input Enable discrete input

Available Terminal Shafts and Drive Shafts

The following terminal shafts and drive shafts are available:

Standard—

- 0.625–36 serrated terminal shaft
- 0.625–36 serrated drive shaft
- 0.625 keyed drive shaft with 0.625-18 thread

Available (for special applications at additional cost)—

Terminal Shafts—

- 0.562 / 0.625 D-shaped terminal shaft
- 0.500–36 serrated terminal shaft with one missing serration
- 0.500–36 serrated terminal shaft on RH or LH side only

Keyed Drive Shafts—

- 0.750–6 splined drive shaft
- 1.125–48 serrated drive shaft [with PG-style base adapter]
- French standard BNA 227 NF-E22-151 0.16-31 drive shaft
- RHD6 drive shaft

Extended 0.625 keyed drive shaft

UG-Governor Similarities

The base is designed to fit any drive designed for a UG governor. The terminal shaft location relative to the mounting base is similar to a UG governor.

Hydraulic Pump

The UG-25⁺ is equipped with a Gerotor pump (3161 governor type). High speed and low speed pumps are available, depending on the drive speed from the engine. The pump uses oil from its self-contained sump to provide 1035 kPa (150 psi) internal operating pressure. The high speed pump is capable of 1500 grpm maximum continuous operation; 1200 grpm max for the low speed pump.

The direction of rotation is selected by pump housing alignment. The pump operates in one direction only. The drive uses a maximum of 335 W (0.45 hp).

References

The following publications provide additional information about installation, operation, and storage of Woodward products. All are available on the Woodward website (www.woodward.com).

Publication

25071	Oils for Hydraulic Controls
25075	Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls
50516	Governor Linkage for Butterfly Control Valve
03339	UG-25 ⁺ Product Specification

Contact your nearest Woodward Distributor or Authorized Independent Service Facility about repairs.

Serviceability

No field-replaceable parts

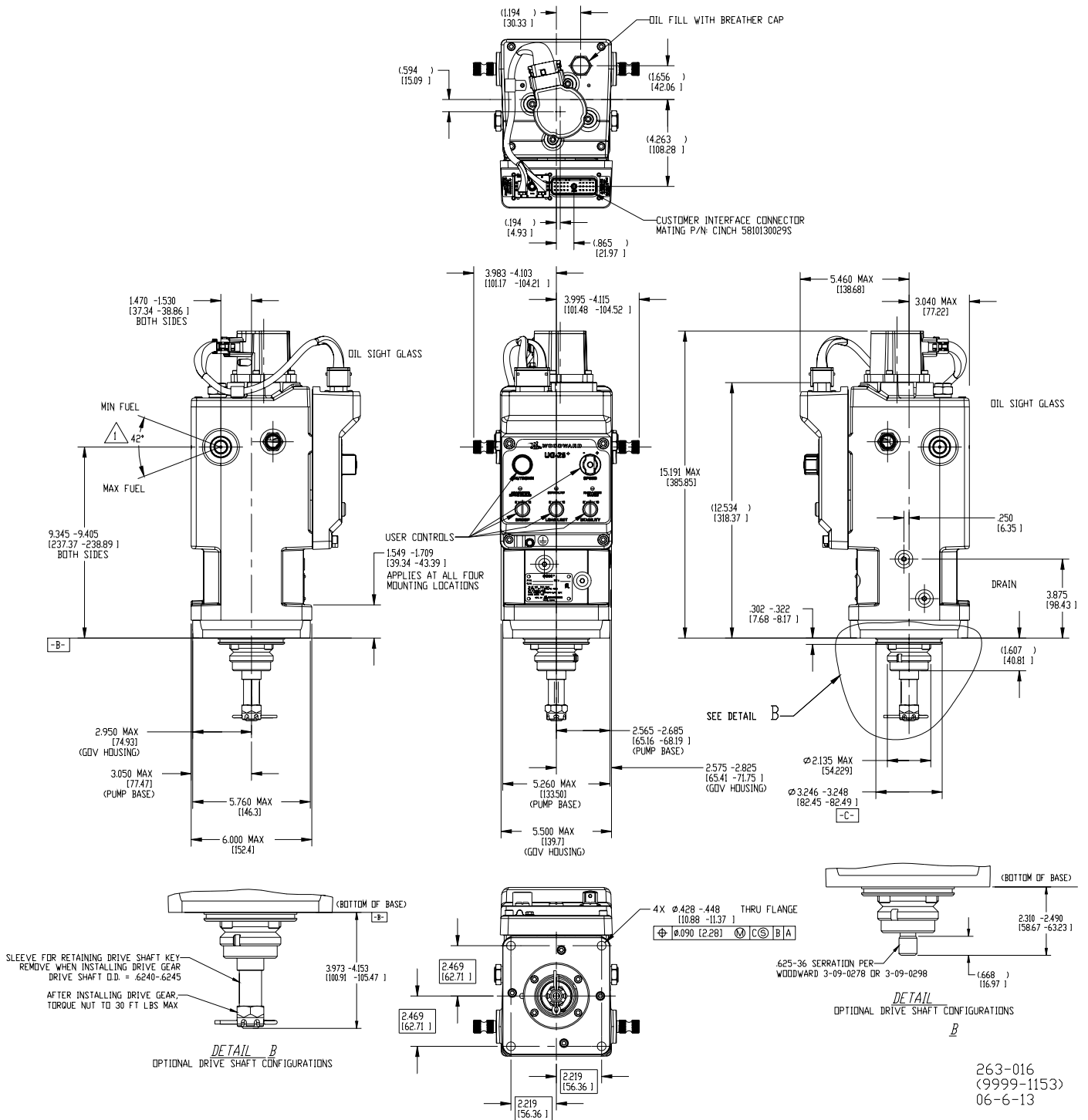


Figure 1-1. UG-25⁺ Outline Drawing

Chapter 2. Installation Procedure

Introduction

This chapter describes receiving, storage, and installation requirements for the UG-25⁺.

Use care while handling and installing the UG-25⁺. Be particularly careful to avoid striking the drive shaft, terminal shaft, or the electrical connector. Abuse can damage seals, internal parts, and factory adjustments. Do not set the governor on its drive shaft.

**WARNING—NOISE**

Due to typical noise levels in turbine or engine environments, hearing protection should be worn when working on or around the UG-25⁺.

**WARNING—BURN HAZARD**

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

**WARNING—INDEPENDENT SHUTDOWN DEVICE**

Use an independent device for positive shutdown, such as a fuel shut-off valve is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

**WARNING—MINIMUM FUEL**

Use of an external spring to return to minimum fuel is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

**WARNING—MINIMUM FUEL SHUTDOWN PROCEDURE**

Use of a predicted minimum fuel shutdown procedure is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

Initial Operation

Before initial operation of the engine equipped with a UG-25⁺, read all of Chapters 2 and 3, Installation Procedures and Electrical Installation. Make sure that all installation steps have been correctly accomplished and all linkages are secured and properly attached. Carefully review the direction of rotation for the actuator oil pump. Configure the software settings following the instructions in Chapter 6.

Follow this procedure when putting a new or repaired UG into service.

1. Check that the actuator is full of the proper type and grade of clean oil.

2. Properly adjust the linkage.

**WARNING—LINKAGE OVERTRAVEL**

To prevent possible serious injury or loss of life, or damage to the engine, be sure to allow sufficient overtravel at each end of the terminal shaft so the actuator can shut down the engine, and also give maximum fuel when required. Misadjusted linkage could prevent the actuator from shutting down the engine.

3. Select a low speed setting to give low engine speed at initial start-up.

**WARNING—EMERGENCY STOP**

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

4. Follow the engine manufacturer's instructions, and start the engine.
5. Adjust the selected speed setting to bring the engine to rated speed.
6. Obtain system stability as outlined in the electronic control instruction manual. (If less than the recommended actuator output stroke is used, it may cause for less than optimum engine stability or response.)

All operating adjustments of the UG-25⁺ are made during factory calibration. Additional adjustment should not be needed.

Unpacking

Be careful when unpacking the module. Check the unit for signs of damage, such as bent or dented panels, scratches, and loose or broken parts. Notify the shipper and Woodward if damage is found.

Receiving

After factory testing and calibration, the UG-25⁺ is drained of oil. This leaves a light film of oil on internal parts to prevent rust. External parts are painted or coated with a spray lubricant/rust inhibitor.

No internal cleaning or flushing is necessary before installation and operation. The little oil left in the governor is clean, multi-viscosity engine oil, which will not contaminate the oil selected to operate the governor.

Fill the governor with 2.1 liters (2.2 quarts) of oil selected to match the expected operating conditions. (If the governor is a direct replacement for a UG governor, you may use the same grade and weight of oil that was being used in the governor.) Use only new, clean oil in the governor. Do not allow dirt or contamination to enter the governor while filling with operating oil. Do not use oil drained from the UG governor.

Figure 2-1 UG-25⁺ Governor Overview

Storage

The UG-25⁺ may be stored for short periods of time (less than a year) as received from the factory. For long-term storage (more than a year), storage in an environment with large temperature changes, humid or corrosive atmosphere, etc., or if the governor is installed on the engine for storage, fill the governor with oil and follow preservation packaging instructions in Woodward manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*.

Drive Shaft Rotation

The governor drive-shaft rotation is one direction only. Rotation, as viewed from the top of the governor, must be the same as that of the engine drive when looking down on the mounting pad.

If the governor oil pump is rotated in the wrong direction, oil pressure will not be generated in the governor.

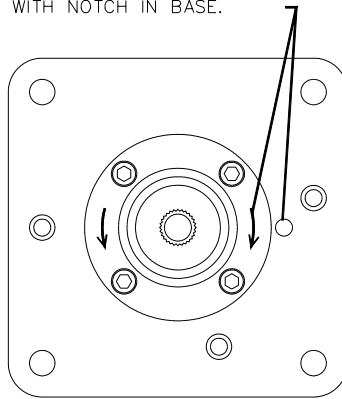


CAUTION—DRIVE ROTATION

Be sure engine mounting-pad drive and governor-drive rotation are the same. Incorrect drive rotation will cause the governor to become inoperative, and may cause governor damage.

THIS FIGURE SHOWS COUNTERCLOCKWISE
ROTATION WHEN VIEWED FROM TOP OF ACTUATOR.

ALIGN THE ROTATION ARROW
WITH NOTCH IN BASE.



820-552
96-12-13

Use the following procedure to change the direction of rotation:

1. Remove the four pump-housing screws.
2. Index the pump plate 180 degrees to align the arrow corresponding to the direction of rotation selected with the reference notch in the base.
3. Replace the four screws, and torque the screws to 10.2 N·m (90 lb-in).
4. Make sure that the governor drive shaft rotates freely.

Mounting Location

Locate the UG-25⁺ a distance from sources of extreme radiant heat, such as exhaust manifolds or turbochargers. The ambient operating temperature range of the control is 0 to 55 °C (32 to +131 °F). In spark-ignited applications, make sure the UG-25⁺ is located away from the ignition coil, and that harness wires are not routed next to the spark plug wires.

As shown in the specifications, the UG-25⁺ has been designed for and verified to a given accelerated life vibration test level at the mounting surface of the governor. The user should be aware that in any application, bracket design could significantly change the vibration levels at the module. Therefore, every effort should be made to make the bracket as stiff as possible so that engine vibrations are not amplified, creating an even more severe environment at the module.

Attitude

The UG-25⁺ can be installed in a vertical or near vertical position without affecting its calibration. Do not install more than 45 degrees from vertical. See the outline drawing for installation instructions and dimensions.

Mounting Dimension

When using the O-ring supplied with the governor to seal between the governor and governor mounting pad on the engine, the mounting hole should have dimensions of 82.7–83.2 mm (3.255–3.275 inches) in order to provide the correct amount of squeeze on the o-ring. The mounting hole must be concentric with the drive in order to avoid side-loading the governor drive shaft.

Drive Connection

Make sure the governor drive shaft turns freely before installing the governor. The drive gear or coupling must slip freely into the governor drive of the engine. Torque the nut that secures the drive gear to 40.7 N·m (30 lb-ft) maximum.

Do not apply external force. The drive must be free of binding, side load, or excess end-play. Improper alignment or fit between the parts can result in excessive wear or governor-drive seizure.

Mount the governor squarely on the mounting pad. Torque the mounting bolts evenly. There can be no movement or rocking of the governor on the engine-mounting pad.

Control Linkage

The terminal shaft rotates 42 degrees. Use 2/3 of the total rotation between no load and full load. The additional “overtravel” should be split and used at both ends to provide maximum fuel when required and to assure shutdown at minimum-fuel governor position (see Figure 2-2).

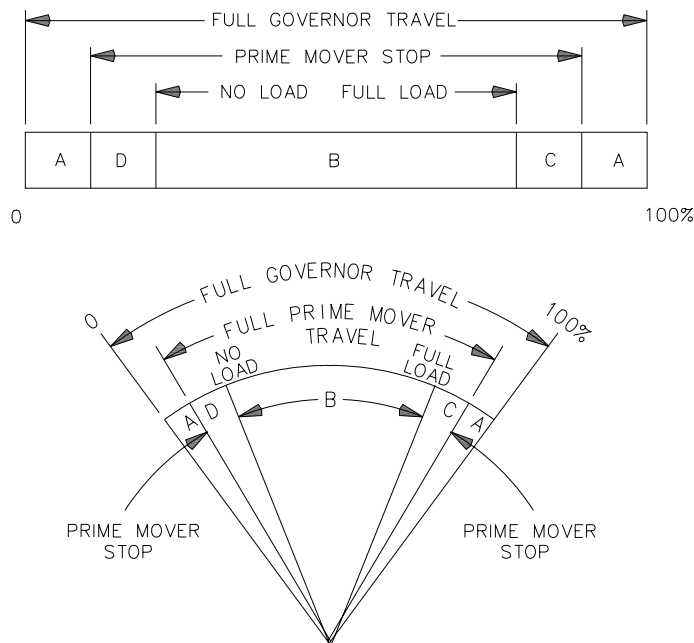


WARNING—TERMINAL SHAFT OVERTRAVEL

To prevent possible serious injury or loss of life, or damage to the engine, be sure to allow sufficient overtravel at each end of the terminal shaft so the governor can shut down the engine, and also give maximum fuel when required. Misadjusted linkage could prevent the governor from shutting down the engine.

Many control problems are related to the linkage between the governor and the engine. Use only first-quality rod ends for the linkage, rod ends that will last under the nearly constant motion associated with precise speed control. The linkage must be stiff, not subject to engine-caused vibration. The linkage must be as light as possible and still maintain the attributes of stiffness. Linkage which is too heavy can damage the governor as well as make it difficult to achieve steady control.

Installed linkages must operate smoothly, be free of binding, and free of lost motion due to worn parts. If there is a collapsible member in the linkage, be sure it does not yield each time the governor moves the linkage rapidly.



- A – OVERTRAVEL TO INSURE PRIME MOVER STOPS ARE REACHED.
- B – NO LOAD TO FULL LOAD TRAVEL – NORMALLY 2/3 OF FULL GOVERNOR TRAVEL IS RECOMMENDED.
- C – TRAVEL REQUIRED TO ACCELERATE THE PRIME MOVER.
- D – TRAVEL REQUIRED TO DECELERATE OR SHUT DOWN PRIME MOVER.

MI-153a
98-04-14 skw

Figure 2-2. Terminal Shaft Travel

Use a linear linkage for most diesel applications. Most gas-fueled engines will require a non-linear linkage. See Figures 2-3 and 2-4 for information on the arrangements of linear and nonlinear connections. Linear linkage moves the fuel setting shaft in direct proportion to the movement of the governor output.

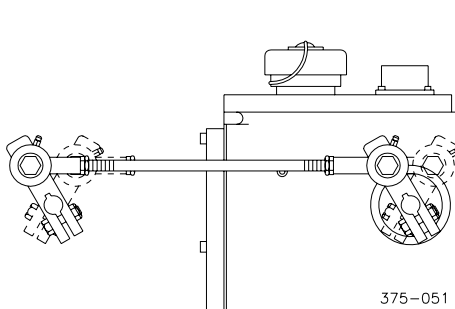


Figure 2-3. Linear Linkage

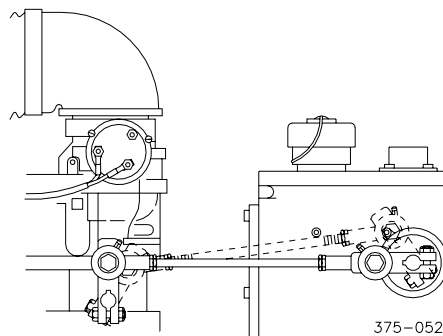


Figure 2-4. Non-linear Linkage

Non-linear fuel arrangement lets the governor open the fuel setting more at maximum settings than it does at minimum settings. Woodward application note 50516, *Governor Linkage for Butterfly Throttle Valves*, provides more information about non-linear linkage.

Design the linkage so the power output of the engine is proportional to the position of the governor output shaft.

Follow the engine manufacturer's instructions on linkage selection, installation, and adjustment. In almost all cases, the linkage designed for a UG-8 governor will work with the UG-25⁺. In the case of a direct exchange, make sure that the linkage is in good condition and the installation of the lever on the governor is in the same position as it was on the old governor.

Oil Supply

Use the information given in Figures 2-5 and 2-6 as a guide in the selection of a suitable oil. Oil grade selection is based on the operating temperature range of the governor. Also use this information to aid in recognizing and correcting common problems associated with oil used in the governor. Many operation and maintenance problems associated with UG-25⁺s are directly related to the selection and condition of the oil in the governor. Use care in the selection and make sure that the oil in the governor is not contaminated.

The oil in the UG-25⁺ is both a lubricating and hydraulic oil. It must have a viscosity index that allows it to perform over the operating temperature range and it must have the proper blending of additives that cause it to remain stable and predictable over this range.

The UG-25⁺ is designed to give stable operation with most oils, if the fluid viscosity at the operating temperature is within a 50 to 3000 SUS (Saybolt Universal Seconds) range (see Figure 2-6). Poor governor response or instability is an indication that the oil is too thick or too thin.

Governor oil must be compatible with seal material, that is, nitrile, polyacrylic, and fluorocarbon. Many automotive and gas engine oils, industrial lubricating oils, and other oils of mineral or synthetic origin meet these requirements.

Fill the governor with about 2.1 liters (2.2 quarts) of oil, to a level visible in the oil sight glass. After the engine is started and the governor is at operating temperature, add oil if necessary. Oil must be visible in the glass under all operating conditions.

Excessive component wear or seizure in the governor indicates the possibility of:

1. Insufficient lubrication caused by:
 - an oil that flows slowly when it is cold, especially during start-up;
 - no oil in the governor.
2. Contaminated oil caused by:
 - dirty oil containers;
 - an governor exposed to heating and cooling cycles, which created
 - condensation of water in the oil.
3. Oil not suitable for the operating conditions caused by:
 - changes in ambient temperature;
 - an improper oil level which creates foamy, aerated oil.

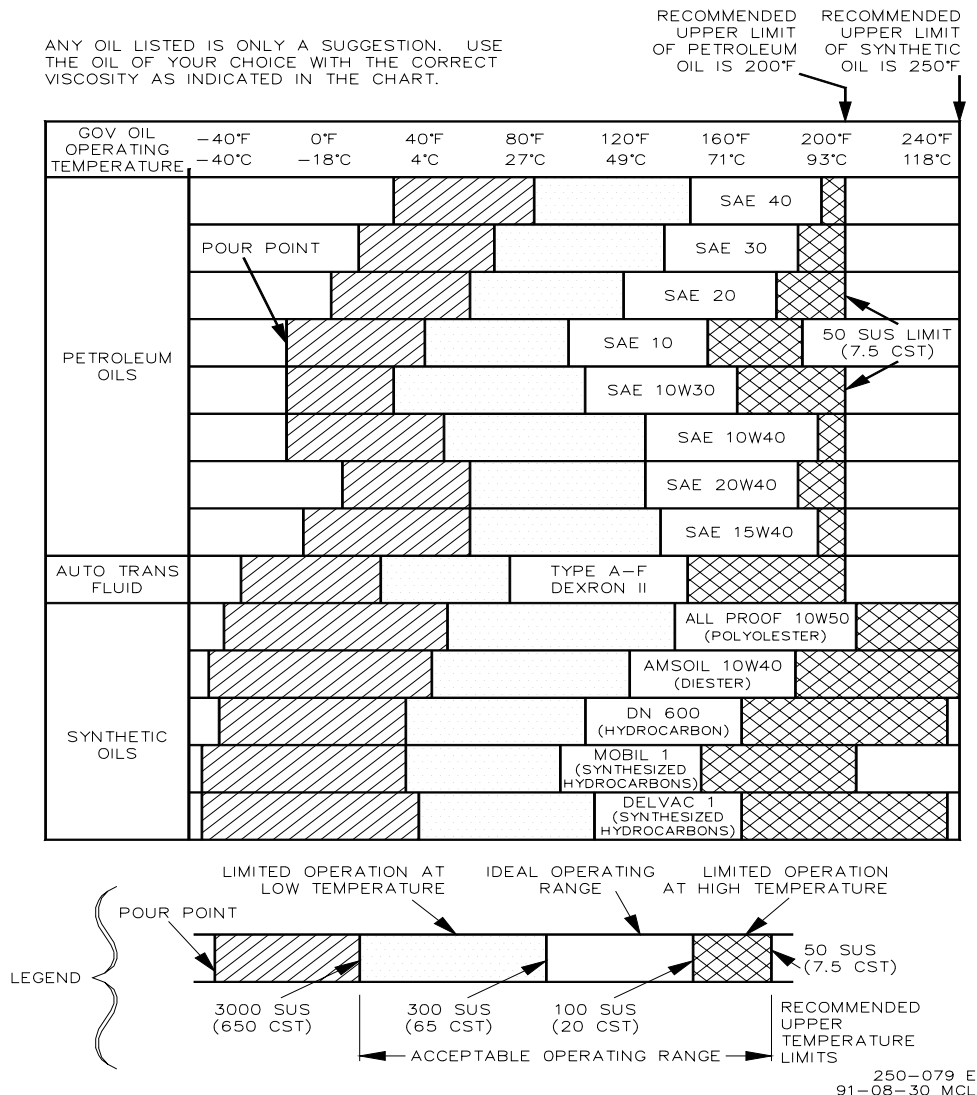


Figure 2-5. Oil Chart

Operating an governor continuously beyond the high limit temperature of the oil will result in oil oxidation. This is identified by varnish or sludge deposits on the governor parts. To reduce oil oxidation, lower the governor operating temperature with a heat exchanger or other means, or change to an oil more oxidation-resistant at the operating temperature.

**WARNING—OVERSPEED**

To prevent possible serious injury or loss of life, or damage to the engine, resulting from engine overspeed or a runaway engine, be sure to use only oil that falls within the 50 to 3000 SUS range. Using oils outside this range could cause the governor to be unable to prevent a runaway engine.

VISCOSITY COMPARISONS				
CENTISTOKES (CST, CS, OR CTS)	SAYBOLT UNIVERSAL SECONDS (SUS) NOMINAL AT 100 DEGREES F	SAE MOTOR (APPROXIMATE)	SAE GEAR (APPROXIMATE)	ISO
15	80	5W		15
22	106	5W		22
32	151	10W	75	32
46	214	10	75	46
68	310	20	80	68
100	463	30	80	100
150	696	40	85	150
220	1020	50	90	220
320	1483	60	115	320
460	2133	70	140	460

250-087
97-11-04 skw

Figure 2-6. Viscosity Comparisons

Oil Maintenance

Replace the governor oil if it is contaminated, and change it if it is suspected of contributing to instability. Drain the oil while it is still hot. Flush the governor with a clean solvent having some lubricating quality (fuel oil or kerosene) before refilling with new oil. If drain time is insufficient for the solvent to completely drain or evaporate, flush the governor with the same oil it is being refilled with to avoid dilution and possible contamination of the new oil.

Oil that has been carefully selected to match the operating conditions and is compatible with governor components should give long service between oil changes. Check oil conditions regularly and change oil if any deterioration or contamination is suspected.

Regularly scheduled oil changes will extend the life of the governor and improve governor operation. Properly selected oil should permit annual oil changes, but more frequent changes are recommended.



WARNING—EXPLOSION HAZARD

Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2.



AVERTISSEMENT—RISQUE D'EXPLOSION

Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous vous situez bien dans une zone non explosive.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2.

**CAUTION—WIRING**

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 3-1a and 3-1b).

Electrical Connection

The electrical connector on the UG-25⁺ is a 30-pin Cinch connector (581-01-30-029S). Seal plugs are required for all unused pins. The mating connector kits can be ordered from Woodward. see Chapter 3 for electrical connection details.

Heat Exchanger

A heat exchanger is not available for the UG-25⁺.

Chapter 3.

UG-25⁺ Electrical Installation

Introduction

This chapter provides instructions for making the proper electrical connections to the UG-25⁺. Detailed wiring diagrams and recommended wiring practices are given to make the electrical installation as straightforward as possible. There are several functional wiring options for UG-25⁺, and these are outlined in this chapter. The only input that is absolutely required is a power connection; all others are optional features. All wiring and accessories (connectors, pins, plugs, etc) are provided by the customer, but are shown in this chapter for ease of assembly.

The UG-25⁺ has an operating voltage range of 18 to 32 Vdc. It is reverse input polarity protected, and consumes approximately 27W maximum power at a peak current of 1.5 A (18 V) at 25 °C. Maximum power at the UG-25⁺ is only realized if an internal fault occurs. Nominal operating current will be less than 500 mA at 24V nominal.

The control system should be protected with a 6 A fuse in the voltage supply lines. The application should be configured to apply power to the UG-25⁺ when the engine is first cranked, or slightly before.

Unit Grounding

The Governor housing must be bonded to earth through the mechanical mounting interface in order to ensure proper EMC and Safety compliance. Do this using a 1" wide braided grounding strap with as short a travel as possible. The ground strap can be tied to the ground post on the front of the governor, directly below the user interface panel.



Shielded Wiring

The use of cable with individually shielded-twisted pairs is required where indicated by the control-wiring diagram (figure 3-1a). Cable shields must be terminated as indicated in the control-wiring diagram using the installation notes described below. DO NOT attempt to directly ground the shield at both ends or an undesired ground loop condition may occur. If it becomes necessary to terminate the shield at the end opposite of the UG-25⁺, it must be done through a high-frequency capacitor.

Installation Notes

- Wires exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches).
- The shield termination wire (or drain wire) should be kept as short as possible, not exceeding 50 mm (2 inches), and where possible the diameter should be maximized.
- Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

Failure to provide shielding can produce abnormal conditions which are difficult to diagnose. Proper shielding at the time of installation is required to assure satisfactory operation of the product.



WARNING—INDEPENDENT SAFETY DEVICES

External independent safety devices are always recommended by Woodward. Fuse the Power Input +(J1-30-F3) with a 6 A fuse. Fuse Boost Pressure Sensor Power Output+ (Pin J1-30-E3) with a 500 mA fuse. See Figure 3-1a.



NOTE

Safe connector mating procedures are always recommended by Woodward. This implies checking both ends of the connector system for debris that may prevent reliable connection and also checking for proper keying of the connectors involved. Do this prior to mating.



NOTE

Proper installation procedures are always recommended by Woodward.



WARNING—POWER LOSS ANNUNCIATION

This UG-25⁺ does NOT provide for power loss annunciation. Woodward recommends that the device that is powered by this UG-25⁺ have an independent power loss annunciation.



WARNING—EXPLOSION HAZARD

Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

**CAUTION—INGRESS PROTECTION**

The control will only meet ingress protection specifications while the Cinch connector is installed in the unit. As such, the unit should not be exposed to operating environments unless the mating connector is installed. In addition, if a wire is not used for each of the 30 pins, a Cinch 581-00-00-011 Seal Plug must be used in place of each missing wire. To ensure proper connector sealing, the wiring insulation diameter must meet the sealing diameter specifications. Failure to adhere to these guidelines may result in product failure or decreased life.

Electrical Connections

Prior to installation, refer to the wiring diagrams and the representative I/O interfaces schematic in this chapter. Also, review the hardware I/O specifications in Appendix B.

Use 1.3 mm² (16 AWG) stranded copper wire with insulation that meets temperature requirements in the harness design. A wiring harness stress relief within 400 mm (16") of the control's connector is recommended.

Dress the harness with wire loom to contain it in a single bundle. Use grommets when passing the harness through metal panels.

Recommended Wire Specifications

1.3 mm² (16 AWG), Minimum Insulation O.D. 1.96 mm (0.077"), -65 to +200 °C, 1000 Vrms, 19/29 Stranded Conductor, Teflon Insulation (TFE)

Connector

The following customer supplied connector components are recommended for harness designs

	<u>Woodward P/N</u>	<u>Cinch P/N</u>
Mating Connector (30 position)	1635-1082	581-01-30-029S
Sockets	1602-1007	425-00-00-873
Seal Plug	1223-1006	581-00-00-011

**** All of the connector components above can be purchased from Woodward as a kit by specifying Woodward Item Number 6995-1092.**

Recommended Tools

Connector Fabrication Hand Tools Kit 6995-1009 (*available for purchase from Woodward*)

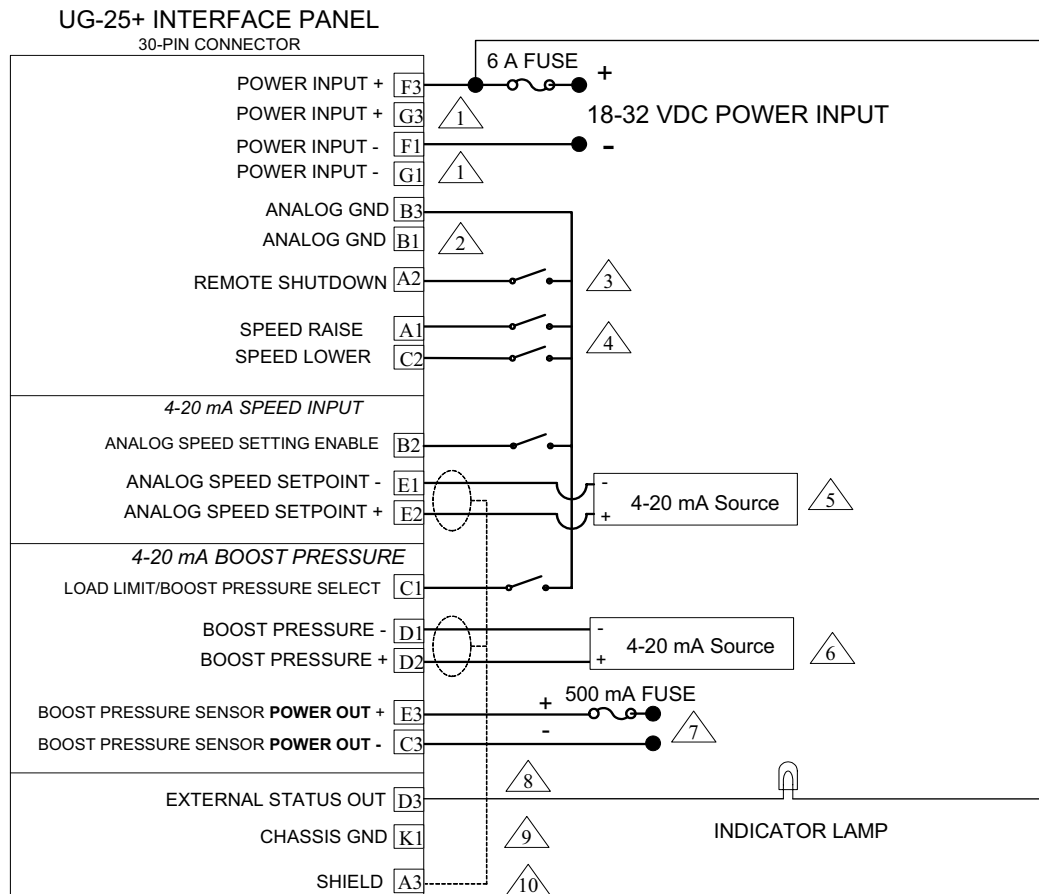
Contains the following tools:

Terminal Crimp Tool	8996-2000	599-11-11-616
Terminal Removal Tool	8996-2001	581-01-18-920
Rnd Lock Removal Tool-30 pin	8996-2002	581-01-30-916

**NOTE**

This kit also includes the lock removal tool for the 18-pin connector, but there is no need to modify connections in the 18-pin harness.

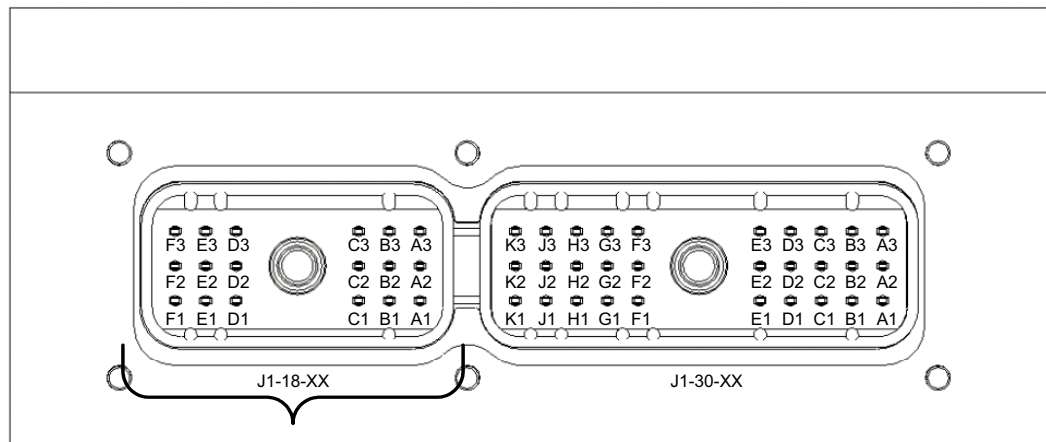
- Insert seal plugs in all empty connector wire ports.
- Customer wiring to be 16 or 18 AWG.



- 1 WHEN USING REDUNDANT POWER, CONNECT TO PIN G3 AND PIN G1. OTHERWISE LEAVE THESE PINS FLOATING.
- 2 A REDUNDANT ANALOG GROUND IS PROVIDED.
- 3 WHEN USING REMOTE SHUTDOWN, CONNECT AS SHOWN.
- 4 WHEN USING REMOTE SPEED RAISE/LOWER, CONNECT AS SHOWN.
- 5 WHEN USING 4-20 mA SPEED INPUT. PIN B2 MUST BE CONNECTED TO ANALOG GND.
- 6 WHEN USING 4-20 mA BOOST PRESSURE, PIN C1 MUST BE CONNECTED TO ANALOG GND. IF PIN C1 IS LEFT FLOATING THEN LOAD LIMIT IS SELECTED.
- 7 POWER FOR THE BOOST PRESSURE SENSOR IS PROVIDED, IF NEEDED. A FUSE SHOULD BE USED AS SHOWN. THIS IS AN **OUTPUT** VOLTAGE THAT FOLLOWS FROM THE POWER INPUT+ (F3 & G3).
- 8 THIS IS AN OPTIONAL HOOKUP. THIS PROVIDES FOR A REMOTE "UNIT HEALTHY" STATUS.
- 9 CHASSIS GROUND IS PROVIDED, IF NEEDED.
- 10 A SHIELD CONNECTION IS PROVIDED, IF NEEDED.

GENERAL NOTE: FLOATING INPUTS ON THE PINS A1, A2, B2, C1, C2 IS ACCEPTABLE BECAUSE THEY ARE INTERNALLY PULLED-UP TO +7 VDC. EXTERNAL PULL-UPS ARE *NOT* REQUIRED *NOR* RECOMMENDED.

Figure 3-1a. UG-25+ Application Wiring



↑ This is for factory wiring only. Do not modify any connections made to this side of the connector.

Figure 3-1b. UG-25⁺ Connector Pin Arrangement as Viewed from Top

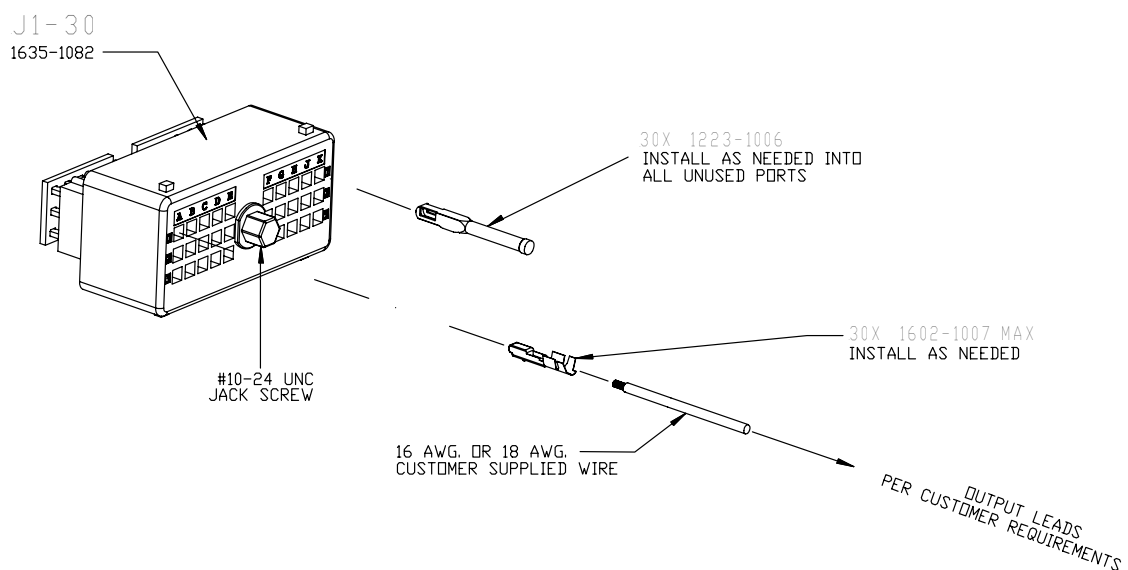


Figure 3-2. Connector Wiring Assembly



CAUTION—WIRING

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 2-7a and 2-7b).

**WARNING—EXPLOSION HAZARD**

Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

**CAUTION—INGRESS PROTECTION**

The control will only meet ingress protection specifications while the Cinch connector is installed in the unit. As such, the unit should not be exposed to operating environments unless the mating connector is installed. In addition, if a wire is not used for each of the 30 pins, a Cinch 581-00-00-011 Seal Plug must be used in place of each missing wire. To ensure proper connector sealing, the wiring insulation diameter must meet the sealing diameter specifications. Failure to adhere to these guidelines may result in product failure or decreased life.

Customer I/O Pin Assignment (30-Pin Connector)

Connector Pin #	Description	Comment	Type
J1-30-A1	Remote Speed Raise	Connecting this pin to Analog Ground <i>increases</i> the UG-25 ⁺ governor speed. This pin is internally pulled-up to 7 Vdc.	Input
J1-30-A2	Remote Shutdown	Connecting this pin to Analog Ground turns OFF the UG-25 ⁺ governor. See UG-25 ⁺ software manual for more details. This pin is internally pulled-up to 7Vdc.	Input
J1-30-A3	Shield	This pin is a conditioned shield tie point. (capacitively coupled to Chassis Ground)	N/A
J1-30-B1	Analog Ground	Circuit Ground for following functions: Remote Shutdown, Remote Speed Raise, Remote Speed Lower, Analog Speed Setting Enabled, Load Limit/Boost Pressure Select. <i>Do not connect Analog Ground to Input Power (-)</i>	N/A
J1-30-B2	Analog Speed Setting Enabled	This pin <i>must</i> be connected to Analog Ground in order to use the 4–20 mA Analog Speed Set Point. This pin is internally pulled-up to 7 Vdc.	Input

Connector Pin #	Description	Comment	Type
J1-30-B3	Analog Ground	Circuit Ground for the following functions: Remote Shutdown, Remote Speed Raise, Remote Speed Lower , Analog Speed Setting Enabled, Load Limit/Boost Pressure Select. <i>Do not connect Analog Ground to Input Power (-)</i>	N/A
J1-30-C1	Load Limit/Boost Pressure Select	When pin J1-30-C1 floats, Load Limit is selected. When pin J1-30-C1 is connected to Analog Ground, Boost Pressure is selected. This pin is internally pulled-up to 7Vdc.	Input
J1-30-C2	Remote Speed Lower	Connecting this pin to Analog Ground <i>decreases</i> the UG-25 ⁺ governor speed. This pin is internally pulled-up to 7Vdc.	Input
J1-30-C3	Boost Pressure Sensor Power Out –	Return for Supply Power for External Boost Pressure sensor. <i>Do not connect Analog Ground to this pin.</i>	Output
J1-30-D1	Boost Pressure Input –	This is the negative input of the 4–20 mA circuitry. Pin J1-30-C1 <i>must</i> be connected to Analog Ground to use this function.	Input
J1-30-D2	Boost Pressure Input +	This is the positive input of the 4–20 mA circuitry. Pin J1-30-C1 <i>must</i> be connected to Analog Ground to use this function.	Input
J1-30-D3	External Status Output	This provides for a remote “Unit Healthy” status. See UG-25 ⁺ Application Wiring Figure 3-1a.	Output, open drain, low-side switch.
J1-30-E1	Analog Spd Set Point –	This is the negative input of 4–20 mA circuitry. Pin J1-30-B2 <i>must</i> be connected to Analog Ground to use this function.	Input
J1-30-E2	Analog Spd Set Point +	This is the positive input of 4–20 mA circuitry. Pin J1-30-B2 <i>must</i> be connected to Analog Ground to use this function.	Input

Connector Pin #	Description	Comment	Type
J1-30-E3	Boost Pressure Sensor Power Out +	Supply Power for External Boost Pressure sensor. This is an <i>output</i> only! Do not connect external power to this power output. This output voltage follows the Power Input(+) minus a protection diode drop.	Output
J1-30-F1	Power Input –	Return for 18-32 Vdc Power Input.	Input
J1-30-F2	No Connection	No Connection	
J1-30-F3	Power Input +	Supply Power (18-32 Vdc)	Input
J1-30-G1	Power Input –	Return for 18-32 Vdc Power Input.	Input
J1-30-G2	No Connection	No Connection	
J1-30-G3	Power Input +	Supply Power (18-32 Vdc)	Input
J1-30-H1	No Connection	No Connection	
J1-30-H2	No Connection	No Connection	
J1-30-H3	No Connection	No Connection	
J1-30-J1	No Connection	No Connection	
J1-30-J2	No Connection	No Connection	
J1-30-J3	No Connection	No Connection	
J1-30-K1	Chassis Ground	This pin connects to Chassis ground through the circuit board, and then to the UG-25 ⁺ metal housing.	N/A
J1-30-K2	No Connection	No Connection	
J1-30-K3	No Connection	No Connection	

Detailed Description of UG-25⁺ Electrical I/O

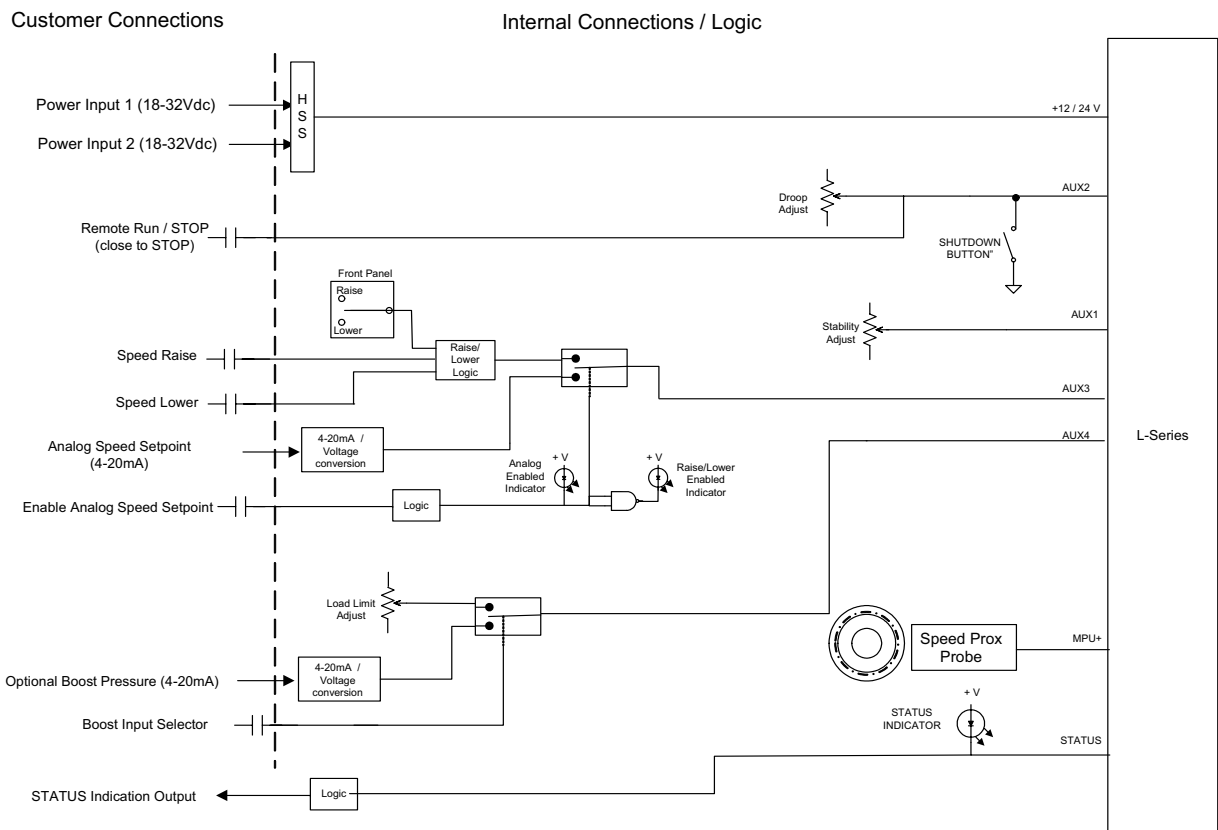


Figure 3-3. Internal Block Diagram

Power Supply Input 1 (18–32 V at pin J1-30-F3, Power Input – at pin J1-30-F1)
Power Supply Input 2 (18–32 V at pin J1-30-G3, Power Input – at pin J1-30-G1)

The UG-25⁺ will handle a voltage range of 18 to 32 Vdc, with an absolute maximum of 60 V.

The power supply terminals are reverse polarity protected, and in the case that a reverse polarity condition exists, the UG-25⁺ will not power-up and the output will remain at 0 Vdc.

Woodward recommends using a 6 A fuse on the power supply line feeding J1-30-F3 and J1-30-G3 of the UG-25⁺.



WARNING—FUSE INPUT POWER

The input power must be fused. Failure to fuse the UG-25⁺ could, under exceptional circumstances, lead to personal injury, damage to the control valve, and/or explosion.



CAUTION—EMI SUSCEPTIBILITY

If circuit ground and chassis ground are shorted together at the UG-25⁺, there is an increased risk of EMI susceptibility.

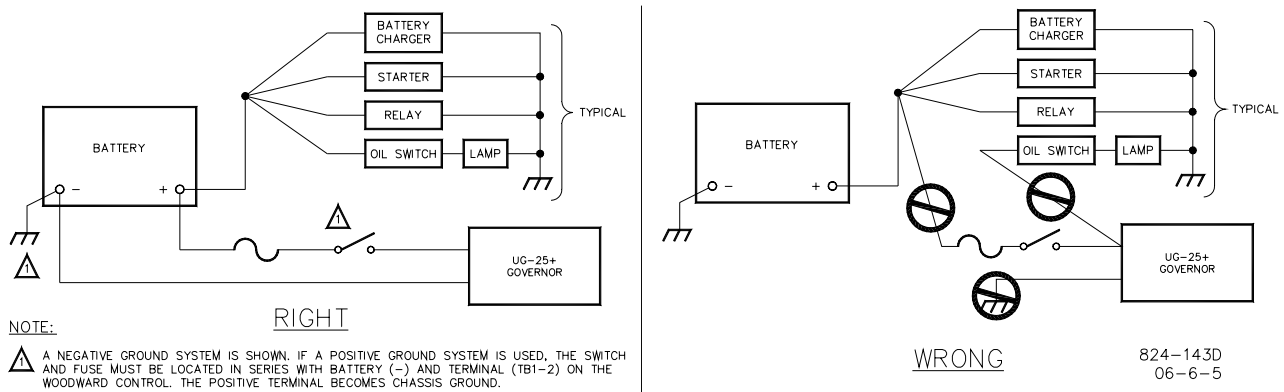


Figure 3-4. Correct and Incorrect Wiring to Power Supply

Woodward recommends using a 6 A fuse on the 14 Vdc output as show in Figure 3-1a.



WARNING—FUSE INPUT POWER

The 18-32 Vdc input power must be fused. Failure to fuse the UG-25⁺ input could, under exceptional circumstances, lead to personal injury, damage to the UG-25⁺ and/or engine, and/or explosion.

Relay Driver Output

A discrete output is provided to serve as a status indicator, mimicking the front panel Unit Health LED. This switchable discrete output is a closure to ground capable of sinking 250 mA with an output voltage rise of less than 1.5 V, and it is available to power external relays for devices such as alarms or fuel shutoff solenoids. The circuit is protected internally against over-current and inductive spikes, so external clamping is not necessary.

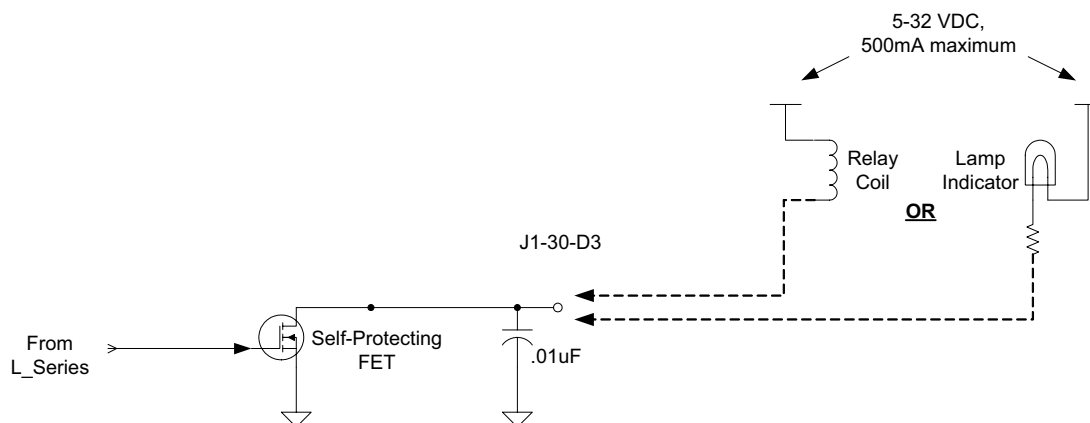


Figure 3-5. Relay Driver Output

Analog Speed Set Point

This input accepts a 4–20 mA current input that is proportional to a desired speed set point. In order to use this input, the external Analog Speed Set Point Enable signal must be connected to Analog Ground.

**NOTE**

The user must clamp the speed bias input at 3 mA and 21 mA. Below 3 mA, the analog bias could get disabled and a 'speed lower' command could be issued. Above 21 mA, a 'raise speed' command may be issued even though the Analog indication LED is on.

Analog Speed Set Point Enable

The Analog Speed Setting Enable allows for remote speed settings. This input is enabled when the input is pulled to ground (0 Vdc). When this signal is not grounded, it can remain floating (no connection).

Boost Fuel Limit Input

This input accepts a 4–20 mA current input that is proportional to a desired boost signal. In order to use this input, the external Load Limit/Boost Pressure Select signal must be connected to Analog Ground.

Boost Input Selector

This external customer input allows the user to select either Load Limit or Boost Pressure. If the input floats, then Load Limit is selected. If the input connects with Analog Ground, then Boost Pressure is selected.

Speed Raise/Lower command

The UG-25⁺ has both local and remote speed raise/lower capability. The local raise/lower is handled by using a magnetic proximity switch on the PCB that is actuated by a spring-loaded knob, mounted to the panel assembly. The knob can be set to either "+" or "-", but not both simultaneously.

- The remote raise/lower adjustments are made by tying their respective connector pins to ground.
- There is hardware arbitration that must take place for this scheme to work.
- The rules are as follows:
 - 1) If remote raise and remote lower are activated simultaneously, the control will default to "lower".
 - 2) If remote raise and local lower are activated simultaneously, the control will default to "lower".
 - 3) The local raise and lower adjustments have priority over the remote raise and lower adjustments.

Stop command

The shutdown feature of the UG-25⁺ interface panel allows the user to force the governor to min fuel by either hitting the big red button on the front panel, or by tying J1-30-A2 to ground (in situations where the shutdown signal is to come from a control room).

**CAUTION—EMI INTERFERENCE**

To avoid EMI interference between the wire bundle and the interface panel, route the wires out of the connectors away from the panel controls. Do not allow the interface wiring to drape in front of the panel controls.

**CAUTION—MAGNETIC FIELDS**

During installation, avoid placing the interface panel in close proximity with any source of strong magnetic field (permanent magnet motor, magnetized tools, etc.). Strong magnetic fields can inject error into the adjustments available on the front of the interface panel.

Chapter 4. Description of Operation

General

The UG-25⁺ Governor is a digital speed control with integral speed and position feedback. The governor output shaft provides a maximum rotation is 42 degrees for controlling diesel, gas, or dual fuel engines, or steam turbines. The speed set point can be adjusted with a 4–20 mA analog input or with raise/lower discrete inputs.

The UG-25⁺ is supplied with a built-in user interface which provides speed raise/lower and emergency stop functions. Front panel Droop, Stability, and Load Limit adjustments are also available.

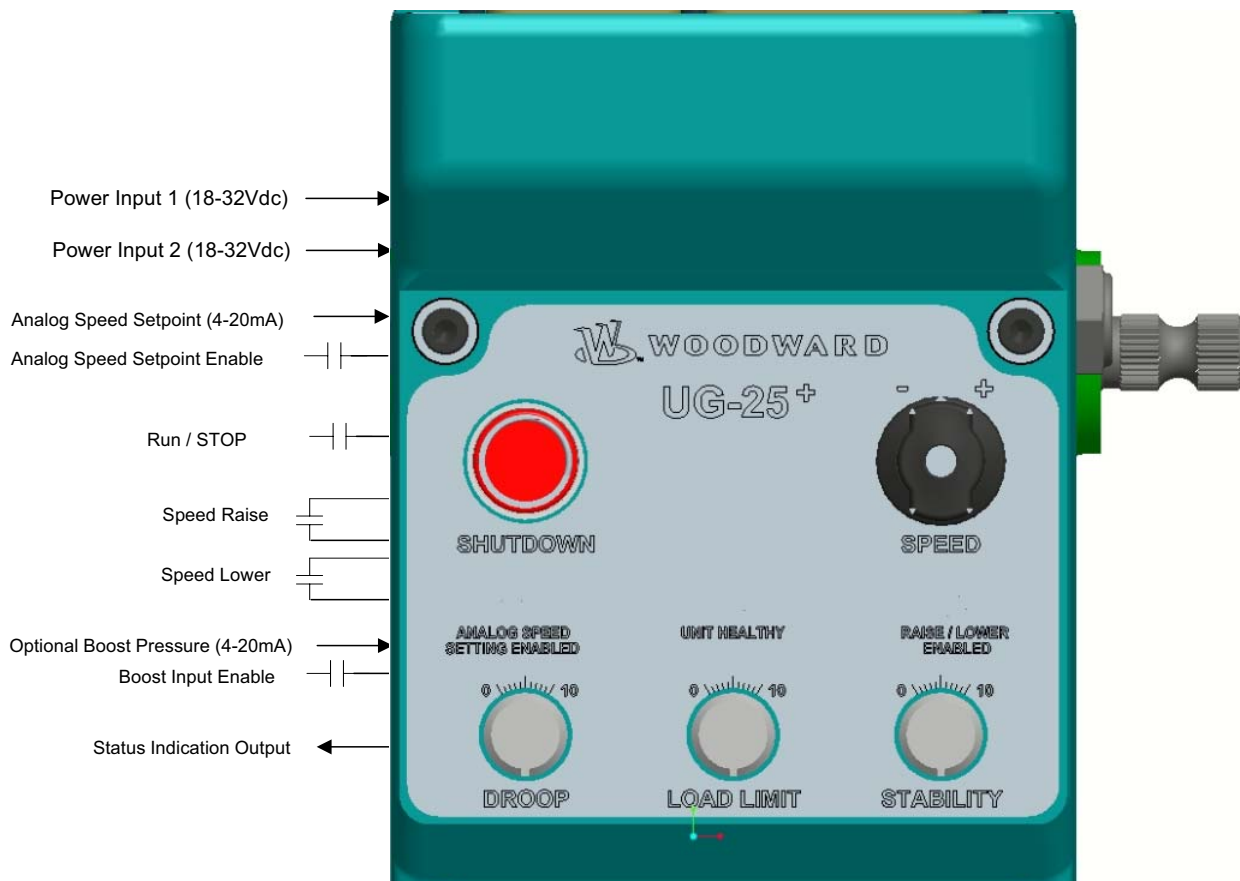


Figure 4-1. UG-25⁺ Overview

Control adjustments are made using the UG-25⁺ Service Tool. The Service Tool is a Windows-based software tool used to configure, monitor, adjust and troubleshoot a UG-25⁺ governor system. It runs on a personal computer and communicates with the UG-25⁺ governor through an RS-232 serial connection. The UG-25⁺ Service Tool includes optional password protection to provide security against tampering.

The speed sensor input contains a filter that minimizes the effects of firing torsionals that occur normally in reciprocating engines. This filter ensures the governor will not react to speed sensor input changes produced by firing torsionals. This provides exceptionally smooth steady-state speed control and allows matching the control dynamics solely to the engine rather than detuning dynamics for firing torsional frequencies.

The control has a switching power supply with excellent spike, ripple, and EMI (electromagnetic interference) rejection. Discrete inputs are capable of rejecting EMI and variable resistance in switch or relay contacts. Analog inputs are differential type with extra filtering for common-mode noise rejection.

The control provides one discrete output, which provides a unit health indication.

**WARNING—EMERGENCY SHUTDOWN**

The UG-25⁺ governor should not be used as the primary means of shutting down the engine.

Principal of Operation

The UG-25⁺ consists of the following 3 main components:

- **L-Series Governor**
Controls prime mover speed/load with proportional rotary output by using speed reference/customer inputs.
- **Hydraulic Amplifier**
Amplifies work output of L-Series governor.
- **User Interface**
Provides local control of droop, load/fuel limiting, stability and shutdown functions. Also provides electrical connector for power and customer inputs.

The hydraulic amplifier operation is depicted in Figure 4-2, which illustrates the working relationship of the various parts. The main elements of the hydraulic amplifier are listed below:

Oil Pump

Gerotor pump configuration. Pump is driven by the governor drive-shaft to provide oil pressure for the governor. The pump is fed oil from the self-contained sump.

Relief Valve

Set to maintain internal operating pressure at 1034 kPa (150 psi).

Rotary to Linear Conversion Mechanism

This mechanism converts rotary to linear motion to operate the pilot valve. It also provides enough linear motion to convert 50 degrees of L-Series travel to 42 degrees of terminal shaft rotation when coupled to the rest of the linkage in the hydraulic amplifier.

Return Spring

Used to provide shutdown to minimum fuel position upon loss of function of the L-Series.

Pilot Valve Plunger

The 3-way pilot valve directs flow to the control side of the differential area power piston or to governor drain.

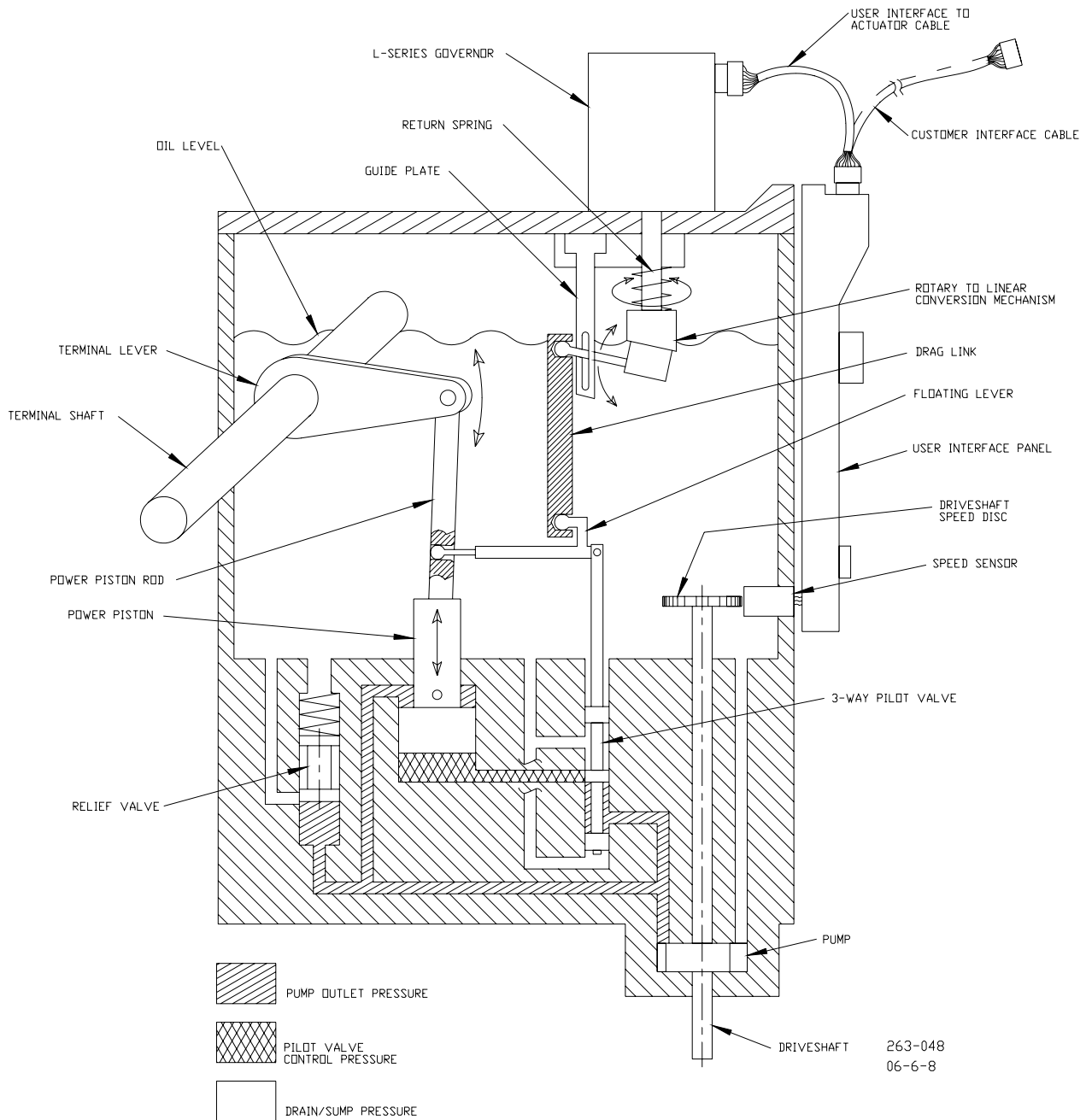


Figure 4-2. Governor Functional Overview

Power Piston, Terminal Lever, and Terminal Shaft

The terminal lever converts the linear motion of the differential-type servo piston to rotary motion of the terminal shaft, which in turn moves the fuel linkage. The terminal-shaft position is fed back to the torque-motor beam to provide the proportional control.

Speed Sensing Disk and Speed Sensor

Drive-shaft driven gear with proximity probe speed sensor used to provide a speed signal to the L-Series governor.

Increase in Load or Speed Setting

An increase in load, or speed setting, causes the L-Series governor output shaft to rotate CCW when viewed from the top on the UG-25⁺. This, in turn, causes the pilot valve to lift allowing control pressure to act on the underside of the power piston. This pressure underneath the power piston opposes the pump outlet pressure acting on the topside and causes the piston to rise, since the piston bottom has twice the area of the topside.

As the power piston rises, the power piston rod moves with it and rotates the terminal shaft, converting the output motion back to rotary. One end of the floating lever is directly connected to the power piston rod and this end rises correspondingly.

When the desired terminal shaft position is reached due to the correct speed or load setting being achieved, the floating lever provides a mechanical feedback/restoring signal between the power piston rod and the pilot valve. During this condition, the pilot valve will be at its "null" position. Therefore, the L-Series governor and the hydraulic amplifier are proportional devices with their positions a direct function of the load or speed setting.

Decrease in Load or Speed Setting

A decrease in load, or speed setting, causes the L-Series governor output shaft to rotate CW. This, in turn, causes the pilot valve to lower allowing the control pressure acting on the underside of the power piston to flow to drain. The pump outlet pressure acting on the topside of the power piston will cause the piston to lower.

As the power piston lowers, the power piston rod moves with it and rotates the terminal shaft towards the minimum fuel direction. The floating lever then lowers its end coupled to the power piston rod and provides its position feedback/restoring feedback to the power piston and pilot valve.

Loss of Control Voltage

Upon loss of control voltage, the governor terminal shaft goes to minimum fuel, thus offering a safety feature. With loss of control voltage, the L-Series governor loses torque and the force of the loading spring causes the center adjustment to lower. The pilot valve follows, keeping the control port uncovered. Trapped oil escapes to drain, and the servo power piston moves down until it reaches minimum fuel position.

Speed Governor Features Description

As you review the following features, keep in mind that most applications will only require a few of the functions to be activated. The choices are available to provide maximum flexibility in a single package. The user must set up the speed input, speed set point/rates, start settings and fuel limit. From the dynamics functions area the user can set as many or as few as is necessary for stable operation. The user can choose all or none of the security functions depending on the application.

The governor features include:

- Speed Control with Droop and Dynamics features
- Fuel/Load Limiter (both startup and run time)
- Jump & Rate Limiter
- Temperature monitoring
- Run / Stop
- Status discrete output

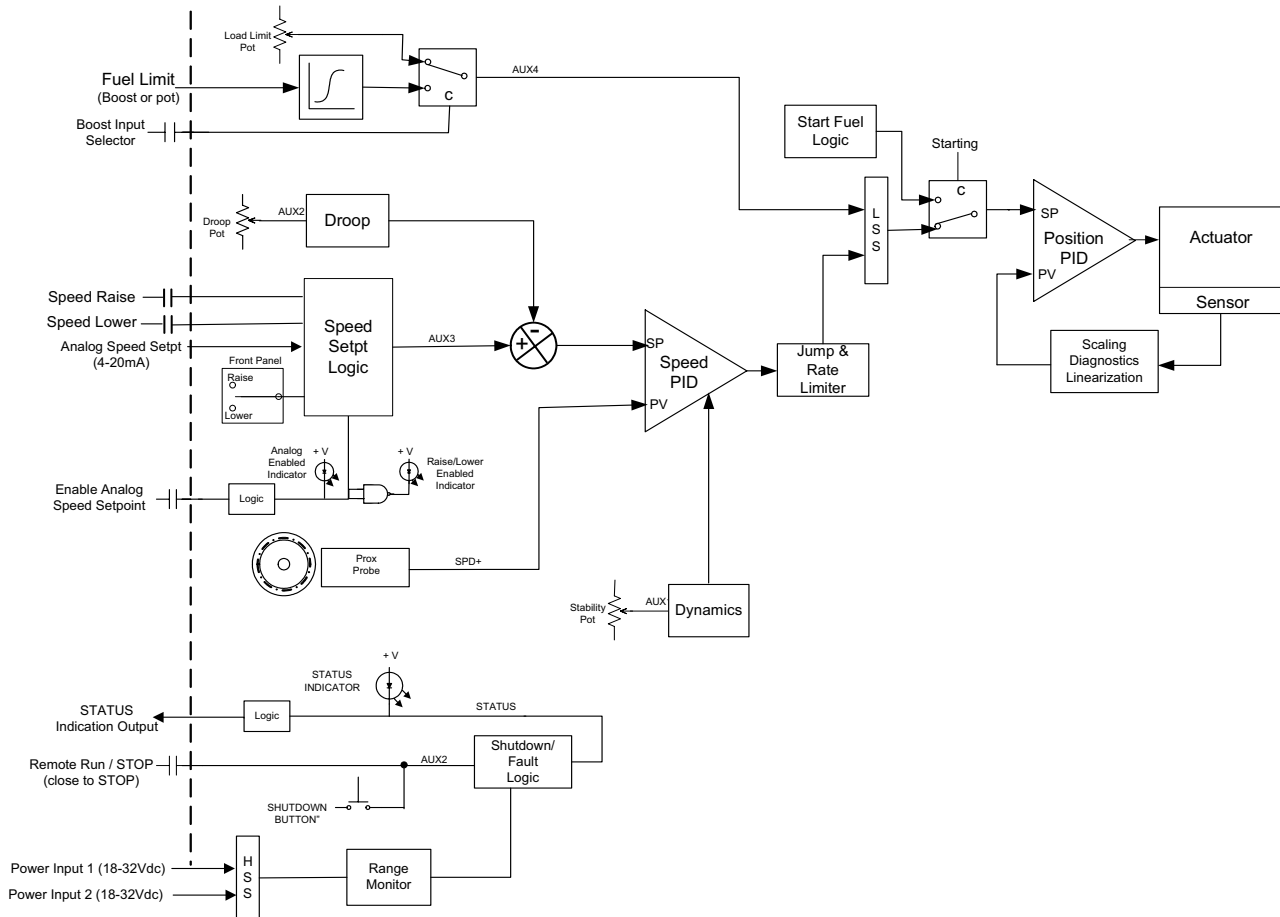


Figure 4-3. Governor Functional Overview

Starting the Engine

The following describes a typical engine starting sequence. The Run/Stop input must be open to permit a start.

When the starter is engaged, the speed will increase above the Start Speed 1 Threshold and the controller will position the shaft to the Start Fuel position demand. If two Start Fuel positions are used and speed increases above the Start Speed 2 Threshold, the controller will position the shaft to the Start Fuel 2 position setting. Once the engine speed is above the Run Speed Threshold, the output will switch from start fuel demand to the fuel demand from the speed controller PID. At this point the unit is in speed control and will control the engine to the speed set point. The PID output is tracking the start fuel values, during a start, providing a bumpless transfer to speed control. Once in speed control, the speed set point increases to the configured start target speed setting - min speed or rated speed.

If a shutdown fault is detected, the control will drive the output to the minimum position.

Speed Control Functions

The speed controller consists of a speed input, speed setting logic, speed biasing logic, and speed dynamics options.

Speed Input

Internally the UG-25⁺ governor houses a proximity probe mounted on a toothed gear, which provides a speed signal to the control. A digital type of detection with firing torsional filtering is used for detecting engine speed. This digital detection method senses speed very quickly for rapid response to speed changes. The input frequency is converted to engine speed based on the speed ratio, number of cylinders and engine stroke settings configured.

Speed Setting Options

The speed control's set point is adjustable with raise or lower commands through the user interface or from remote contact inputs. In addition, a 4–20 mA analog input provides for remote speed set point control.

The speed set point can be in Analog or raise/lower mode. The front panel LEDs will display the active speed set point mode (Analog or raise/lower). When in the Analog mode, the set point signal comes from the UG-25⁺ analog speed set point input (derived externally by a customer supplied device). When in the raise/lower mode, the set point is adjusted using raise and lower commands available both on the front panel and through customer inputs.

Analog Speed Set Point—The Analog Speed Set Point input directly sets the internal speed set point. The maximum rate at which the analog input signal can change the speed set point is programmable. The analog set point is enabled with the Enable Analog Speed Set Point discrete input. The analog set point scaling is based on the Min Speed Limit and Max Speed Limit settings, a 4 mA input corresponds to Min and a 20 mA input corresponds to Max.

Analog Speed Setting mode is active only when the Analog Enable input is closed and the analog input signal is above 2.5 mA. All Set Point Raise/Lower commands are ignored when the Analog Speed Setting mode is active.

The user must clamp the analog speed set point input between 3 and 21 mA. Below 3 mA the analog input could get disabled and a lower command could be issued. Above 21 mA a raise command may be issued even though the Analog indication LED is on.

Lower—The Lower Speed discrete input and front panel Lower command act directly on the internal speed set point and will progressively decrease the speed set point down to a programmable lower limit at the programmed lower rate for as long as the input is selected (closed). When this input is not selected, the speed reference will remain fixed at the last setting.

Raise—The Raise Speed discrete input and front panel Raise command act directly upon the internal speed set point and will progressively increase the speed reference up to a programmable upper limit at the programmed raise rate for as long as the input is selected (closed). When this input goes low, the speed reference will remain at the last setting.

Front panel commands have priority over external commands – when Raise or Lower is selected locally, the remote raise/lower commands are ignored. In the event of a simultaneous external Raise and Lower command, the Lower has priority over a Raise command.

Speed Setting Functions

The control provides run speed, min speed, max speed, and rated speed set points with a lower and raise limit, plus raise and lower ramps and a starting ramp. All ramp rate settings are in rpm/sec and all speed set point changes are ramped for smooth set point transition. For emergency standby applications, a very high ramp rate effectively cancels the ramp function to provide rapid starting. Starting ramp determines how fast speed is increased from run to the start target speed (Min or Rated). Raise and lower rates determine how fast speed is increased or decreased by the raise and lower command inputs and by the remote speed set point input. For additional details on these settings refer to the Overview tab and Set Point tab configuration settings in Chapter 6.

The Run Speed setting must be above cranking speed, but below the speed attained at light-off by the start fuel limit setting. The speed control activates at Run speed by grabbing the current operating speed as the initial speed set point then ramping the set point up to the start target speed setting at the start target speed rate.

If the target speed is Rated and a raise or lower command is selected during the ramp to target (Rated), the speed set point will halt and follow the raise/lower commands. If the halt is issued prior to reaching the Min Set Point Limit, then the set point will continue up until Min prior to stopping.

DROOP

This feature allows for a change in speed set point with a change in load. This feature is primarily used when the generator is connected to a utility bus or paralleled with another gen-set on an isolated bus. In this situation, the utility will determine the frequency of the alternator. Should the governor speed reference be less than the utility frequency, power in the utility bus will flow to the alternator and motor the unit. If the governor speed is even fractionally higher than the frequency of the utility, the governor will go to full load in an attempt to increase the bus speed. Since the definition of a utility is a frequency that is too strong to influence, the engine will remain at full fuel.

Droop is one method of creating stability in a governor. Droop is also used to divide and balance load between units driving the same shaft or paralleled in the electrical system. Droop is the decrease in speed that occurs when the governor output shaft moves from the minimum to the maximum fuel position in response to a load increase, expressed as a percentage of rated speed.

Too little droop can cause instability in the form of hunting, surging, or difficulty in response to a load change. Too much droop can result in slow governor response in picking up or dropping off a load..

Reducing droop to zero allows the unit to change load without changing speed. Normally, set zero droop on units running alone. On interconnected units, set the least amount of droop possible to provide satisfactory load division. For ac generating units tied in with other units, set droop sufficiently high to prevent interchange of load between units. If one unit in the system has enough capacity, set its governor on zero droop, and it will regulate the frequency of the prime mover system. If its capacity is not exceeded, this unit will handle all load changes.

Marks on the droop adjustment scale on the front panel are reference numbers only and do not represent actual droop percentages. The governor droop percentage set by the droop pot is scaled 0 to 18% of the full 42 degrees of output shaft travel, but since the typical application uses 30 degrees travel, the pot roughly corresponds to 10% at full CW position.

The desired engine speed reduces with the following formula:

$$\frac{\text{Rated speed set point} * \text{droop percentage} * (\text{actual position} - \text{no load governor position})}{(\text{full load governor position} - \text{no load governor position})}$$

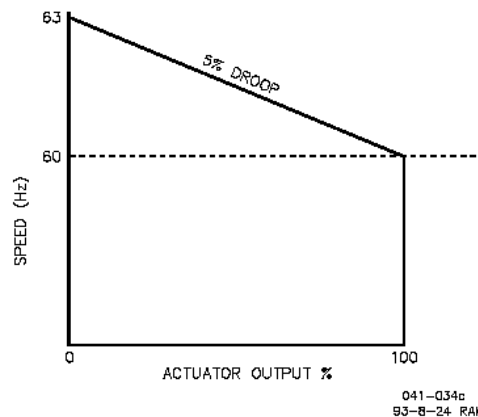


Figure 4-4. 5% Droop Example



WARNING—OVERSPEED

It is recommended that the actual engine speed be used to externally verify that the speed command matches the command signal sent. Failure to comply with this recommendation can result in undetected system faults.

Speed Control Dynamics

The control algorithms used in the UG-25⁺ governor are designed specifically for reciprocating engine applications. The UG-25⁺ offers either a single set of dynamics or a position-based curve. In addition, cold start dynamics and dual gain settings can be configured for use in more demanding applications. These options are described below. A front-panel Stability potentiometer is provided to allow quick access to dynamic performance adjustments. Refer to the Dynamics tab in Chapter 6 for configuration details. Information on tuning of the speed control dynamics is provided in Chapter 7.

Single Gain

If configured for Single Gain, the gain remains constant as entered and does not vary with engine speed or load. These are simplest dynamics and suit most constant speed applications. A single gain setting is typically used on engines that operate continuously at rated speed or on variable speed engines that tend to be stable at all speeds with constant dynamic settings.

Position Curve

A Position Curve varies the proportional gain value with fuel demand (governor position). Fuel demand is roughly proportional to load but not necessarily in a linear manner. A 5-breakpoint gain curve is provided to map gain versus fuel demand. Gain is applied linearly between breakpoints. This gain curve is particularly useful for non-linear fuel systems (e.g., intake butterfly valves).

For all dynamic configurations the Integral and Derivative settings are constant and do not vary with either engine speed or load.

Stability Pot

The front panel stability pot provides an quick adjustment on the speed controller P (proportional) and I (integral) gain terms. This pot output, with a range of 0.25 to 4 X, is multiplied with the nominal gain settings to adjust the resultant performance. When the pot is at mid position, the multiplier is '1.0' and gains are at their nominal configured settings. At full clockwise position, P and I-term gains are multiplied by '4' providing increased response and at full counter-clockwise position the multiplier is at 0.25. The stability pot input and resultant gains can be monitored from the Overview tab on the Service Tool (see Chapter 5).

Cold Start Timer

In demanding gen-set applications that require 'G3' performance but are also intolerant of cold start instability, the UG-25⁺ governor offers a cold start timer function that sets the gain of the controller to a lower-than-normal value until a programmable amount of time expires (see Start Gain and Start Delay settings in Chapter 6). This gives an engine time to warm up slightly before switching to a normal gain value. The cold start timer can be bypassed by programming a time of 0 seconds.

Dual Gain Settings

Gain Window and Gain Ratio settings further modify the applied gain. These Dual Gain Dynamic settings can improve both steady state and transient load performance by automatically switching between two gain settings. A low gain setting is applied during steady-state operation. A high gain setting is applied during load transients. Dual Gain Dynamics are available for all gain configurations.

During steady-state loaded operation, the control uses the primary gain setting (rated gain, idle /rated gain, etc.). In this region, gain is set to prevent the control from responding to minor speed fluctuations inherent with reciprocating engines. This essentially eliminates harmful jiggle of the governor output and the fuel system linkage during steady-state loaded operation.

During load transients, should the speed error exceed the adjustable Gain Window width, the primary gain setting is multiplied by the gain ratio setting to temporarily increase the applied gain. This higher gain produces a faster fuel response to quickly restore engine speed to the speed setting. Speed error is the difference between actual engine speed and the engine speed setting. The primary gain setting is restored once the control senses a return to steady-state operation (see Figure 4-5). Setting the gain ratio to 1 disables the function.

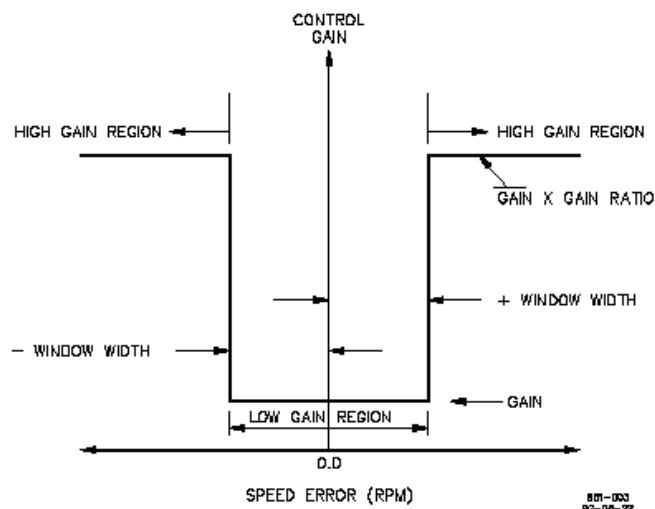


Figure 4-5. Dual Gain Settings

Fuel Limiting

Two modes of fuel limiting are provided, one during startup (start fuel) and one during normal operation (run time).

Start Fuel Limit Function

The Start Fuel Limit (SFL) is an adjustable limiter on the fuel demand that prevents over fueling during engine starting. Two configurable start fuel limiters are available:

- Single Start Fuel Limit
- Dual Start Fuel Limit

The simple Start Fuel Limit is suitable for most applications. With this configuration, the fuel demand immediately switches to the adjustable SFL1 Limit setting when the engine is cranking at the adjustable Start1 Speed setting. The SFL1 Limit is removed once the engine accelerates to the Run Speed. At the Run Speed the fuel is controlled by the speed control set point and ramping functions. The Run Speed setting must be set below the speed reached with the SFL1 Limit setting. See Figure 4-6.

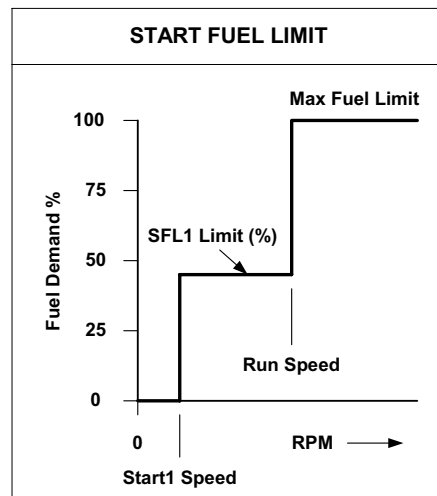


Figure 4-6. Single Start Fuel Limit

The Dual Start Fuel Limit is appropriate for engines that need a rather high fuel setting to start the engine, but a much lower setting immediately thereafter to minimize speed overshoot, black smoke or to prevent an overspeed shutdown. In addition, the SFL2 Limit can be set to increase at a controlled rate, once the engine is operating at the Start2 Speed setting. This is achieved by adjusting the SFL2 Ramp %/sec above zero. This can be a useful aid for starting cold engines. The Dual start Fuel Limit is appropriate for engines that need this ramping function. The SFL2 Limit will not increase beyond an adjustable SFL2 Max.

With this configuration, the Dual Start Fuel Limiter works just like two sequential start fuel limiters plus a ramp. Extra settings Start2 Speed and SFL2 Limit w/Ramp provide the second limiter function between the Start1 Speed and Run Speed. Start2 Speed must be set higher than the Start1 Speed setting. The SFL2 Limit can be set lower or higher than the SFL1 Limit setting. Otherwise, function is the same as the Start Fuel Limit described above. See Figure 4-7.

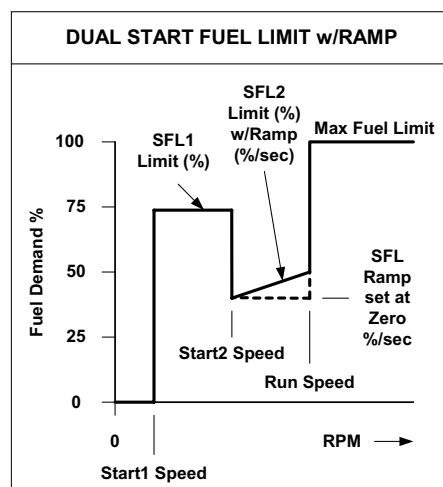


Figure 4-7. Dual Start Fuel Limiters

Run Time Fuel Limiting

During normal operation, the fuel limit is can be set by either the front panel load limit pot or through an external analog setting. The appropriate hardware jumper (see Boost Input Selector discrete input in Chapter 3) AND software configuration selection must be set for the desired input. An absolute Maximum Fuel Limit is also available. Refer to Fuel Limiting tab in Chapter 6 for configuration details.

Maximum Fuel Limit

The Maximum Fuel Limit software setting places a fixed absolute maximum limit on the fuel demand (governor position), independent of the front panel fuel limit pot or analog input. It is generally adjusted to prevent engine overloading at rated speed or to merely limit fuel delivery to the engine for other situations (e.g., to prevent detonation). Configuring the Max Fuel Limit setting to 100 percent disables the function.

Boost (Analog Input) Fuel Limit Function

The Boost fuel limit is a software adjustable five-breakpoint curve based on an external transmitter analog input signal. Manifold Air pressure (MAP) is typically used for the external fuel limiter signal. The purpose of the manifold air pressure fuel limiter is to prevent over fueling during loading to significantly reduce black smoke in diesel engine exhaust and unburned hydrocarbons in spark gas engine exhaust. A fuel demand (governor position) limit is set for each specific air manifold pressure breakpoint.

The limiting value is linear between breakpoints as shown in Figure 4-8. The engineering units for each breakpoint are in percent and user set input units. The limiter must be carefully set since excessive fuel limiting can degrade the loading response. On occasion, exhaust temperature or other engine parameters are used for the external fuel limiting function. The external fuel limiter is disabled whenever the input signal is failed. The external fuel limiter is not active below the run speed setting.

To select this input, the Boost Analog Input must be configured and the Boost Input Selector discrete input must be closed.

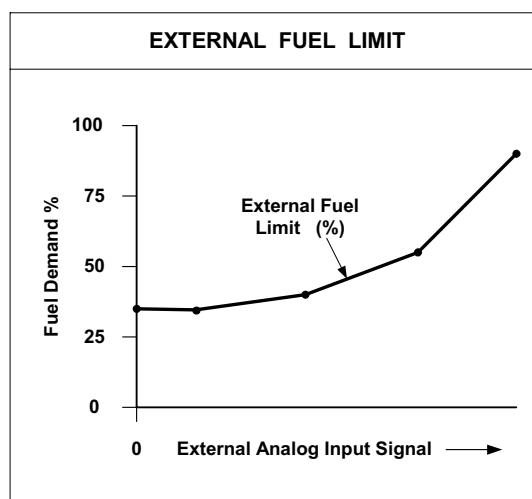


Figure 4-8. Boost (External) Fuel Limit Curve

Fuel Limit Pot

The front panel fuel limit pot is a run time fuel limit that is set based on the position of the potentiometer. The position limit settings for this function is linear from 0%, pot full counter-clockwise, to 100% with the pot fully clockwise.

To select this input, the Front Panel Pot must be configured and the Boost Input Selector discrete input must be open.

Jump and Rate Limiter

A jump and rate limiter is available to limit the governor output position command in the fuel increasing direction. This function provides a limit on instantaneous increases (Max Jump Up) and a limit on the rate of increasing shaft position output (Max Up Rate). Settings of 100% and 200%/sec for Max Jump Up and Max Up Rate, will disable this function. The jump rate limiter is not active below the run speed setting. Refer to Fuel Limiting tab in Chapter 6 for configuration details.

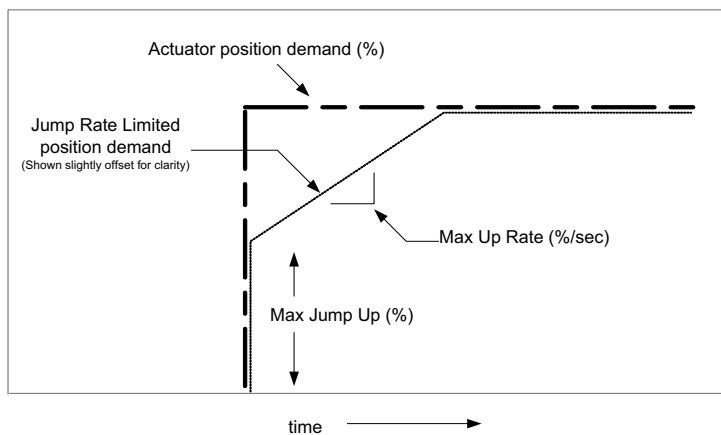


Figure 4-9. Jump Rate Limiter

Discrete Output – Unit Healthy Indication

A discrete output is provided to mimic the front panel 'Unit Healthy' LED. When ON, indicates the unit is powered-on and healthy—it does not indicate a shutdown or alarm condition in the unit. The Service Tool can be used to display all faults, current and historical (logged). When OFF, it indicates an input power high/low or an internal position sensor or EEPROM fault.

Run / Stop Functionality

The UG-25⁺ can be shut down from the front panel or through the external Run/Stop discrete input. When a 'stop' is commanded, the output shaft position will be commanded to minimum (0%).

Temperature Sensing

The UG-25⁺ has an on-board temperature sensor to monitor board temperatures and protect the unit from over-temperature. This temperature is monitored and a fault is annunciated if the set point is exceeded.

Current Limiting based on Temperature

The controller provides governor current limiting based on the electronics temperature. Dependent on board and governor thermal models, the software reduces current as necessary to avoid conditions that would damage the device due to extreme temperatures.

Current limiting based on temperature begins when the combined current and temperature environment causes board temperatures greater than 117 °C. The limit curve is a linear derate from full current at 117 °C down to zero current at 125 °C. At 125 °C, an OverTemp fault is annunciated. Depending on the current (governor torque) and ambient operating temperatures, the unit may never reach a reduced level.

Control Modes

The Service Tool displays the state of the UG-25⁺ governor, the present mode of the unit. Options include:

- Stopping
- Engine Stopped
- Power-down
- Start Fuel 1
- Start Fuel 2
- Ramping
- Running Rated

Stopping

The stopping state indicates the control has a shutdown fault and is driving the output shaft position to the closed position. Once speed has reached zero rpm, the control transfers to the stopped state.

Engine Stopped

In this state the engine is stopped and the control is ready to begin the startup cycle if there are no shutdown's active. After the Stopped State Delay, the holding current is applied to the governor to limit the current draw and prevent battery drain.

Power down

In this state the governor position controller is turned off and the holding current is applied to the governor to limit the current. This state is only used if the engine is stopped and the run enable discrete input is not active.

Start Fuel 1

The Start Fuel 1 state is selected if the engine speed is higher then the Start Speed 1 threshold. In this state the governor position is set to the Start Fuel 1 value.

Start Fuel 2

The Start Fuel 2 state is selected if the engine speed is higher then the Start Speed 2 threshold. In this state the governor position is set to the Start Fuel 2 value. This state is only used if two start fuels are selected.

Ramping

The ramping state is used to ramp from one set point to another set point.

Running Rated

Indicates the unit is running at the rated speed set point or the changed rated set point if raise, lower, or analog control is used.

Fault Detection and Annunciation

The UG-25⁺ provides complete fault monitoring. These faults are set to either alarm or shutdown on occurrence. An alarm basically does nothing but annunciate the fault. A shutdown forces the governor to a predetermined position regardless of the demanded position. The UG-25⁺ is programmed to go to the min fuel (0%) position. When the shutdown condition no longer exists, the UG-25⁺ is returned to a non-shutdown state. Faults are globally set as non-latching. When the condition no longer exists, the fault is automatically cleared without any reset.

Current Faults and Logged Faults

Faults are separated into two categories: Logged Faults and Current Faults. Status of both current and logged faults is provided on the Service Tool. A Current Fault indicates a fault that is presently active/detected and a Logged fault is a fault that occurred since the last time the fault log was cleared. All logged faults are latched and written to the EEPROM. They must be cleared through the Service Tool. Each possible fault is described below.

Alarms

Watchdog Reset

Watchdog Reset is true if a watchdog timer timeout occurred which resulted in a reset of the microprocessor. This is a hard-coded alarm. If detected, the control will attempt to continue normal operation.

Brownout Reset

Brownout Reset is true if CPU Voltage drops below 4.2 V but not below 1 V. The brownout detect circuit will reset the CPU. This is a hard-coded alarm. If detected, the control will attempt to continue normal operation.

Voltage Sense Fail

Indicates an out-of-range signal on the input power. Could indicate input power out of range or a fault in the supply voltage sense circuitry.

Failure levels: >33 V and <6.25 V
Persistence: 650 ms

Temp Sense Fail

Indicates a failure of the internal on-board Temperature Sensor.

Failure levels: >150 °C and <-45 °C
Persistence: 650 ms
Hysteresis: 5 °C (<145 °C or >-40 °C to clear)

OverTemp

If the on-board temperature sensor reads above 125 °C, this error will be set. The Current Limiting based on temperature will effectively make the output "limp" by reducing the drive current to zero (see Current Limiting Based on Temperature section for details).

Failure levels: >125 °C
Persistence: 650 ms
Hysteresis: 5 °C (<120 °C to clear)

Position Error

Position Error detection logic will indicate a difference between commanded position and actual position exceeded for longer than the set delay.

Failure levels: Error > 2.7%

Persistence: 1 sec

Hysteresis: none

Override: Whenever the current is being limited to a factor of 1/2 normal maximum or less. This would be because of high temperature (see section on Temp Sensing and Current Limiting) or a shutdown that causes the output to go "limp".

Shutdowns

Speed Input Failed

Speed input signal failed indication.

Dedicated shutdown. The control will drive to Fail Direction (using position control) if this fault is detected. The control must return to a safe condition, determined as the power-down or stopped state, prior to resuming operation.

Failure levels: < (Start Speed / 2)

Persistence: 13.0 ms

Overspeed

Indication that speed was above the configured overspeed level.

Dedicated shutdown. The control will drive to Fail Direction (using position control) if this fault is detected. The control must return to a safe condition, determined as the power-down or stopped state, prior to resuming operation.

Failure levels: > Overspeed level configured value

Persistence: 6.5 ms

Stop Command

The Stop discrete input is opened or STOP is selected from the front-panel user interface. This is a hard-coded shutdown. This shutdown remains active until the speed has dropped to zero.

Internal Shutdowns

EEPROM Fail

EEPROM Fail indicates failure or corruption of the internal non-volatile memory. If the CRC is not correct for the EEPROM data, this fault will be set true. This is a hard-coded internal shutdown. If detected, the control output will go limp. A power cycle is required to clear this fault.

Position Sense Fail

This indicates a failure of the internal Position Sensor. This is a hard-coded internal shutdown. If detected, the control output will drive to the Fail Direction using current control. This fault latches and requires a reset or power cycle to clear.

Failure levels: >4.75 V and < 0.25 V

Persistence: 650 ms

Chapter 5. Service Tool

Introduction

This chapter covers the process of installing and servicing the control via the UG-25⁺ Service Tool. It is assumed that the control has already been installed on the engine.



NOTE

Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.

Description

The Service Tool software is used to configure, tune, and troubleshoot the UG-25⁺ controller. This chapter describes installation and use of the Service Tool. It identifies the parameters available that can be viewed. It also provides detailed information on configuring and setting up the UG-25⁺ to the customer-specific field application.

The Service Tool software resides on a PC (personal computer) and communicates to the UG-25⁺ through connector pins 4 and 6. An external RS-232 transceiver is necessary to make communications possible with the Woodward UG-25⁺ service tool. A connectivity kit can be purchased from Woodward to accomplish this.

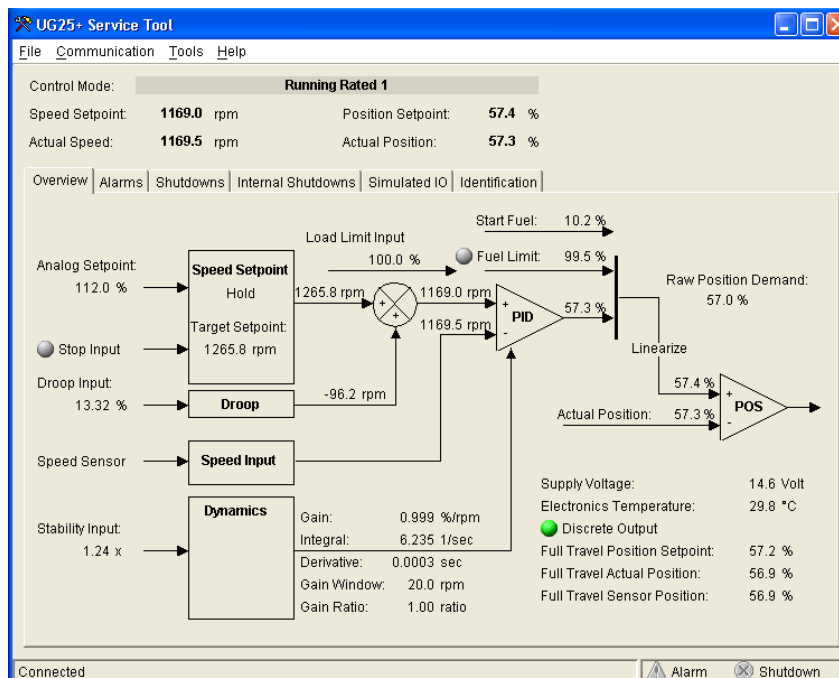


Figure 5-1. Example Service Tool Screen

The following hardware is required to work with the UG-25⁺ control:

- PC-compatible laptop or desktop computer* with at least one available serial communications port, and Windows 95/98/00/NT/Me/XP as the operating system.
- Programming/datalink harness as shown in Figure 5-2.

In addition to the hardware, the following are the distributions of tool software needed to communicate with the control:

- Woodward part number 9927-1366, UG-25⁺ Service Tool

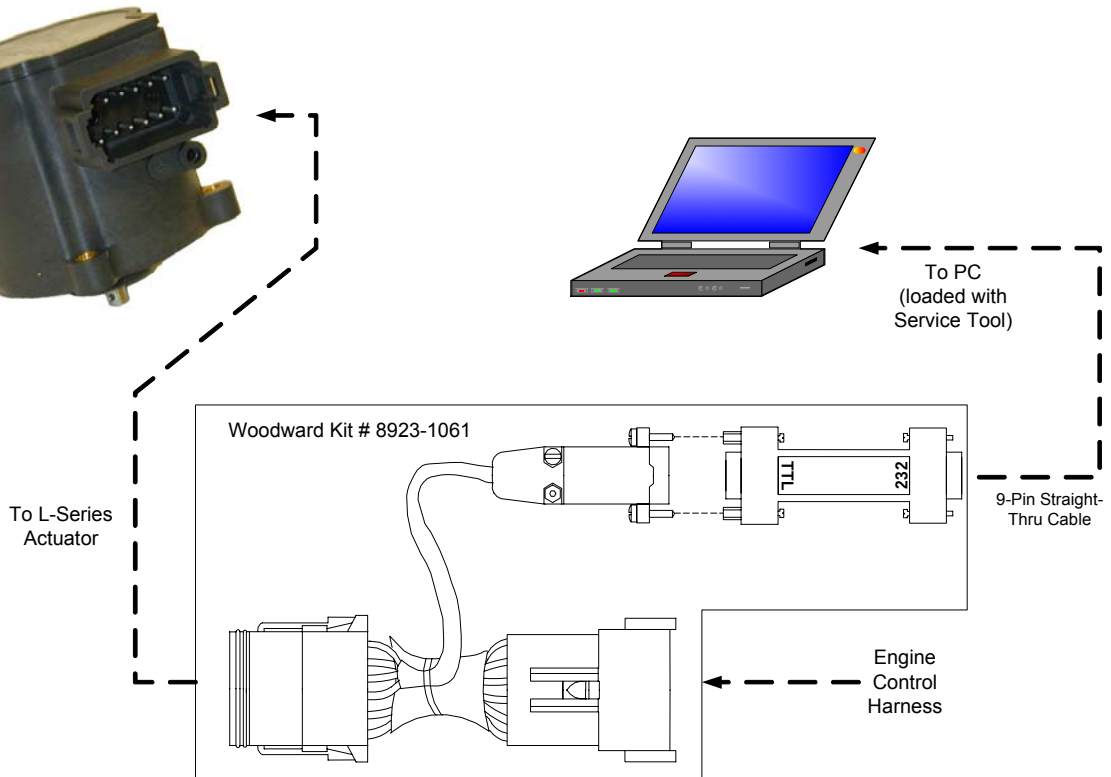


CAUTION—ISOLATION TRANSFORMER

There is a potential for serial port damage when communicating with the UG-25⁺ control. This is caused by a difference in ac voltage between neutral and earth ground. If the PC RS-232 port ground is referenced to ac neutral, and the UG-25⁺ control is referenced to battery ground (ac earth ground), a large amount of current can be experienced. To avoid this situation, we strongly recommend placing an isolation transformer between the ac outlet and the PC.



Figure 5-2a. Programming Harness Connection



Pinouts Viewed Looking into Control Connector and Computer Connector

Figure 5-2b. Typical Programming Datalink Harness Wiring

Getting Started

Harness Connection

The programming harness is required to communicate with the Service Tool. To install the harness, remove the connector from the L-Series and insert the harness between this connector and the L-Series (see Figure 5-2a).

Software Installation Procedure

The Service Tool software can be downloaded and installed from the Woodward internet site (www.woodward.com).

What to do next

After the software is installed, connect a serial communications cable between the RS-232 connections on the UG-25⁺ control and an unused serial port on your computer. Run the Service Tool program and select the appropriate comm port. Once connected to the control, the status bar will display 'connected' and the Service Tool screen will populate with monitor parameters.



WARNING—TRAINED PERSONNEL

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

Service Tool Help

More help on using Service Tool is available and included with the installation of the Service Tool product. Service Tool Help can be accessed from the Service Tool 'Contents' drop-down window selection under the Help menu located on the Main Window.

Software Version Identification

The Service Tool software version can be found by selecting 'About' under the Help menu. The Swift software version is identified as the 'Software Part Number' on the Service Tool screen. The Service Tool and Control must be connected to view this information. Refer to this version information in any correspondence with Woodward.

Service Tool Security

Various levels of security are available to protect application settings. One password is available, which provides the ability to inhibit tampering of control settings. The individual protection settings include a general password protection on configuration reading (from the control), configuration loading (to the control), and speed PID tuning.

Monitoring the Governor

The Service Tool has 6 different tab sheets to monitor governor parameters. The tab sheet screens include:

- Overview (see Figure 5-3)
- Alarms (see Figure 5-4)
- Shutdowns (see Figure 5-5)
- Internal Shutdowns (see Figure 5-6)
- Simulated I/O (see Figure 5-7)
- Identification (see Figure 5-8)

Each screen will display the UG-25⁺ control mode, actual speed, speed set point, position set point, and actual position values.

Control Mode

Displays the state of the UG-25⁺ control, the present mode of the unit. Options include:

- Power-down
- Engine Stopped
- Stopping
- Start Fuel 1
- Start Fuel 2
- Ramping
- Running Rated

Speed Set Point

Displayed value of the speed set point (after droop is subtracted) - in engine rpm.

Actual Speed

Displayed value of the actual speed – in engine rpm.

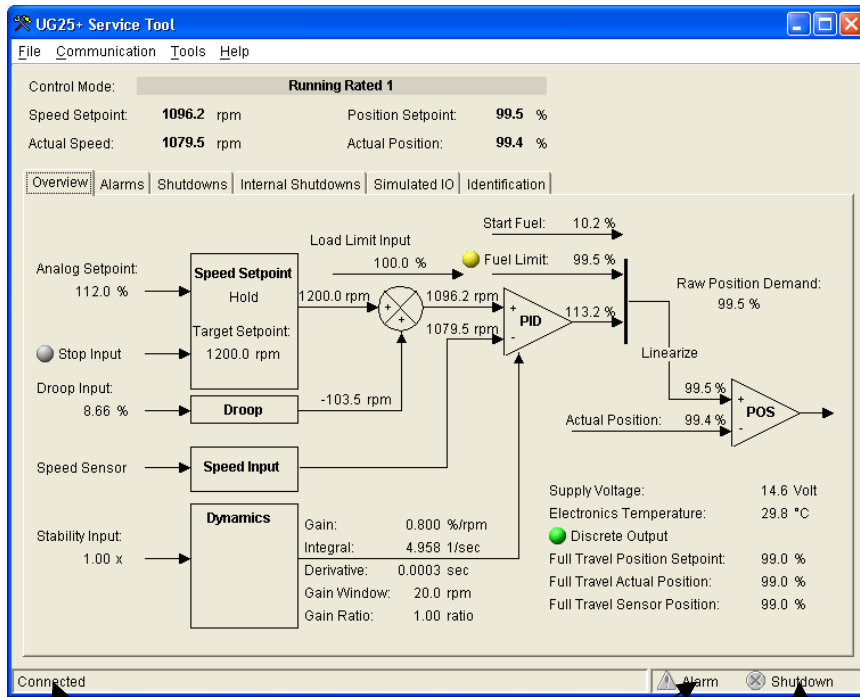


Figure 5-3. Service Tool – Overview Tab

Communication status

Alarm status

Shutdown status

Position Set Point

Displayed value of the position demand - in percent of full travel (42 degrees).

Actual Position

Displayed value of the actual position - in percent of full travel (42 degrees).

Status Bar Indications

At the bottom of the Service Tool window is a status bar. The status bar has two sections. The bottom left section displays communication status and bottom right section displays alarm & shutdown status.

Communication Status

This section of the status bar shows the status of communication between the service tool and the Swift Driver. For more information, see Establishing Communication.

- **Connected**—The Service Tool is connected to and communicating with the driver.
- **Not Connected**—The Service Tool is not connected to the driver.
- **Connecting**—The Service Tool is attempting to connect to the driver. This message is displayed when Connect is selected from the Communications menu or when attempting to re-establish communication to the driver. If the connection is lost it will continuously attempt to re-connect.

Alarm Status

One or more alarms on the Alarms screen is active.

Shutdown Status

One or more shutdowns on the Shutdowns or Internal Shutdowns screen is active.

Overview Parameters Screen

To monitor the overview parameters, go to the Overview page on the main window. This screen dynamically populates based on the unit's configuration. If a function is not programmed, then it will not appear.

Supply Voltage

Displayed value of the input power, in volts, as read by the processor.

Electronics Temperature

Displayed value of the electronics temperature sensor, in degrees Celsius, as read by the processor. The temperature sensor is physically located between the electronics module and the LAT motor.

Discrete Output

On/Off status of the discrete output command. The indicator is illuminated when the channel is commanded to ON and grayed-out when the command signal is OFF.

Full Travel Position Set Point

Indication of the position set point in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Actual Position

Indication of the actual position in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Sensor Position

Indication of the position in terms of total overall unit travel before linearization. This value will match the TPS output.

Shutdown and Alarm Indications

The Shutdown and Alarm screens display the status is both active and logged fault conditions. The logged indications provide a history of events even after the unit has been power-cycle of run again.



Indicates a logged alarm condition.



Indicates an active alarm condition.



Indicates a logged shutdown condition.



Indicates an active shutdown condition.

An active fault is one that is currently active or latched in the control. The latching/non-latching faults configuration setting factors into this indication. If the fault is latching, then an active fault could either be one that is still present or one that occurred but has not been reset. Latched faults can be cleared by cycling power on the UG-25⁺ control or by selecting the 'Reset Alarms and Shutdowns' button on any of the Alarm or Shutdown screens.

A logged fault is one that occurred but is no longer currently active or latched in the control. Logged faults are permanently cleared by selecting the 'Reset Logged Alarms and Shutdowns' button on any of the Alarm or Shutdown screens.

Alarms Screen

To monitor the alarm conditions, go to the Alarms page on the main window. The values displayed on this screen dynamically change with the fault configuration. Refer to Chapter 4 for a complete listing and details of all the faults.

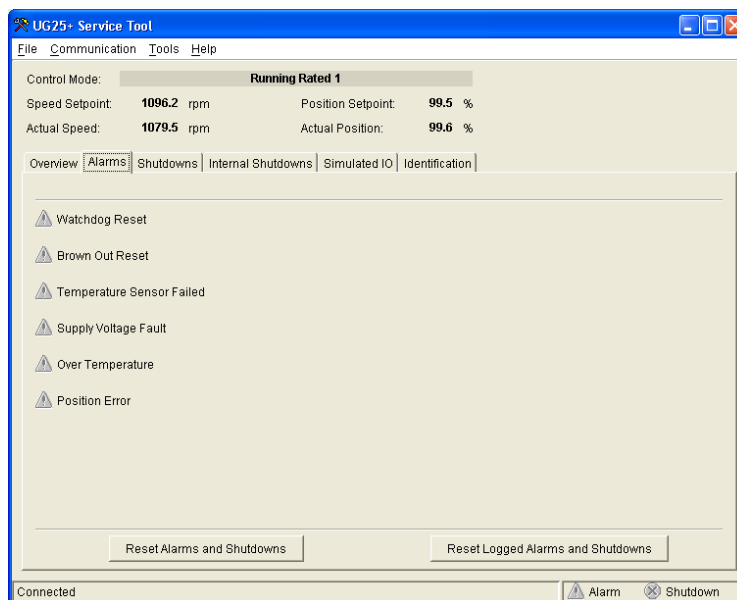


Figure 5-4. Service Tool – Alarms Tab

Shutdowns and Internal Shutdowns Screens

To monitor the shutdown conditions, go to the Shutdowns and the Internal Shutdowns pages (figures 5-5 and 5-6) on the main window. The values displayed on the Shutdowns screen dynamically change with the fault configuration. Refer to Chapter 4 for a complete listing and details of all the faults.

A reset command is available on these screens to clear any current alarms, if they are latched on. If a fault condition occurred but is no longer present, it will remain as a logged fault until cleared. The 'Reset Logged Alarms and Shutdowns' command will clear all logged faults.

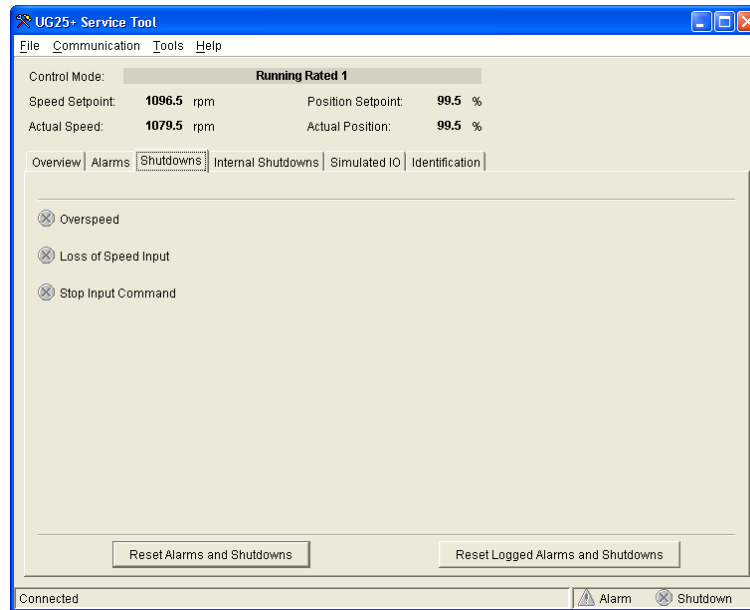


Figure 5-5. Service Tool – Shutdowns Tab

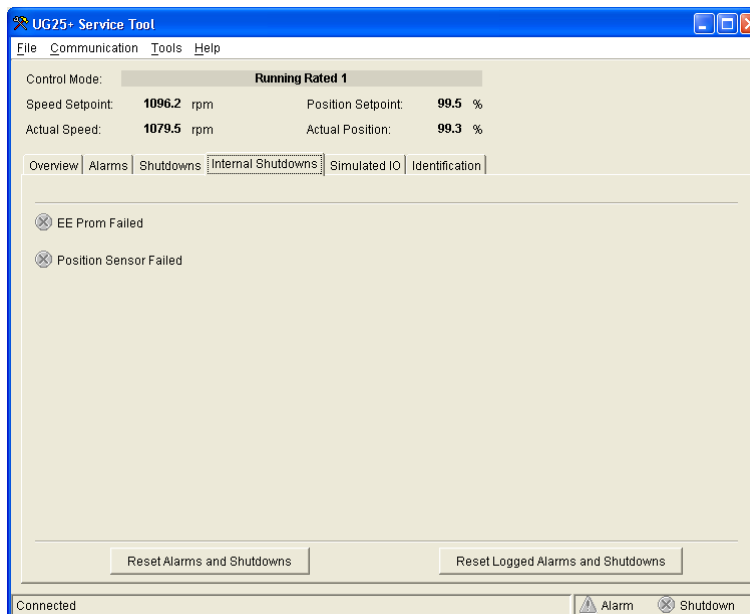


Figure 5-6. Service Tool – Internal Shutdowns Tab

Simulated I/O Screen

While communicating to the service tool, Speed Set Point commands (analog, raise, lower) and Load Limit inputs (Aux 3 and Aux 4) are not functional since these input pins are used for both Input and for serial communications. The Simulated I/O screen (figure 5-7) is provided to facilitate operational testing while connected to the Service Tool.

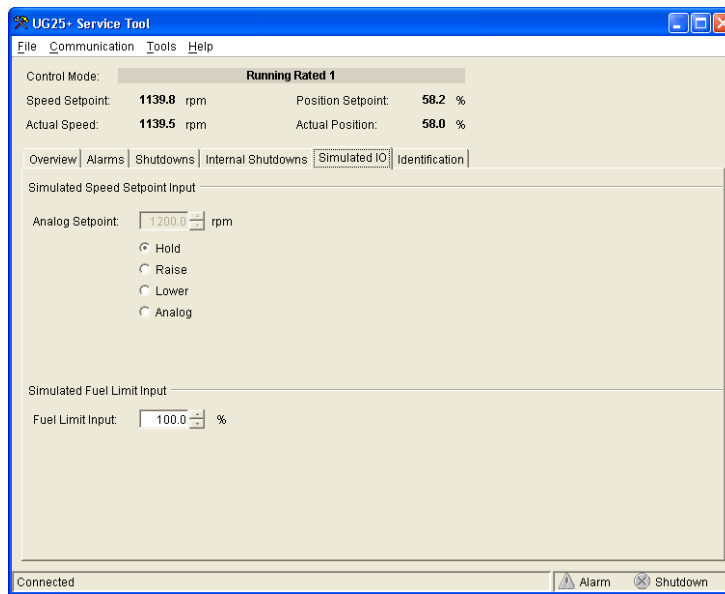


Figure 5-7. Service Tool – Simulated I/O Tab

Identification Screen

To monitor the UG-25⁺ product identification, go to the Identification page on the main window. Information displayed includes the part number of the embedded UG-25⁺ software and the serial number of the unit.

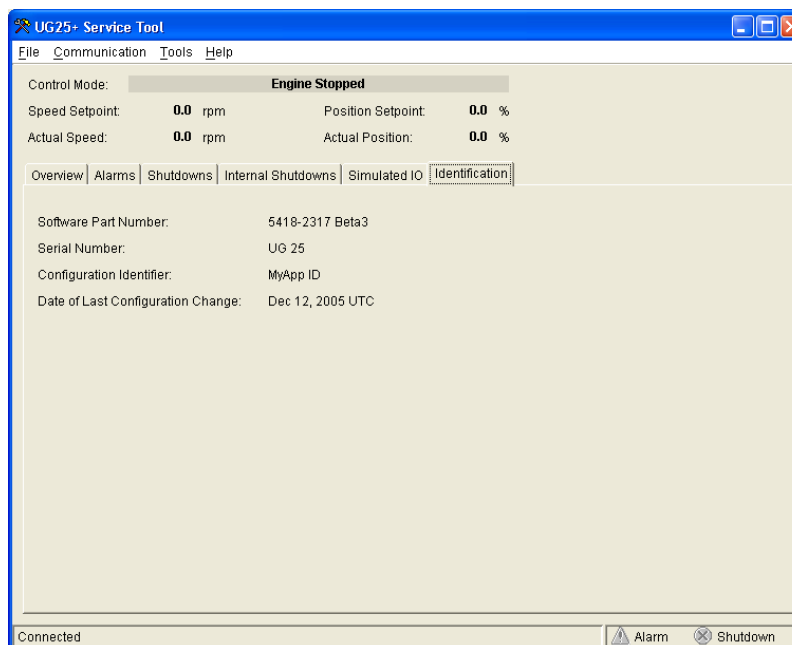


Figure 5-8. Service Tool – Identification Tab

Chapter 6. Configuration

Overview

The UG-25⁺ is configured using the Service Tool, refer to Chapter 5 for Service Tool installation and connection instructions.

The UG-25⁺ can be configured either on-line or off-line. On-line configuration can only be performed when the Service Tool is connected to and communicating with the UG-25⁺ control. Off-line configuration can be done at any time, however, settings will not take effect until they are loaded into the control.



NOTE

Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.

Configuration reading and loading can be individually password protected for security purposes. If security is applied, these features will not be accessible without the password.

If using dynamics curves or fuel limiting curves, control power must be cycled after loading a new configuration before the new settings will take effect.



WARNING—TRAINED PERSONNEL

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

The current UG-25⁺ control configuration settings can be viewed at any time when connected to the control by opening the Configuration Editor (File/Open Control Configuration), assuming password protection is not active. See Figure 6-1.

Configuring the Unit—On-Line

Unit configuration is summarized as follows:

1. Connect to the UG-25⁺ using the Programming Harness (see Chapter 5 for details).
2. Open the Configuration Editor Dialog by selecting 'File/Open Control Configuration'.
3. Edit the configuration settings.
4. Optionally, save the configuration to a file. Saving the configuration prior to loading it will provide an identifier in the control. The first 8 characters are saved in the control, so it is best to ensure these identify the application.
5. Load the configuration to the UG-25⁺ control.



NOTE

As changes are made to Configuration parameters, they are not used by the driver until a 'load' command is issued. Selecting the 'Cancel' button closes the Configuration Editor and does not make any changes to the driver.

Configuring the Unit—Off-Line

Unit configuration is summarized as follows:

1. Open the Configuration Editor Dialog using the File/New or File/Open options.
2. Edit the configuration settings.
3. Save the configuration to a file. At a later date simply open the configuration and load it into the control. The first 8 characters are saved in the control, so it is best to ensure these identify the application.

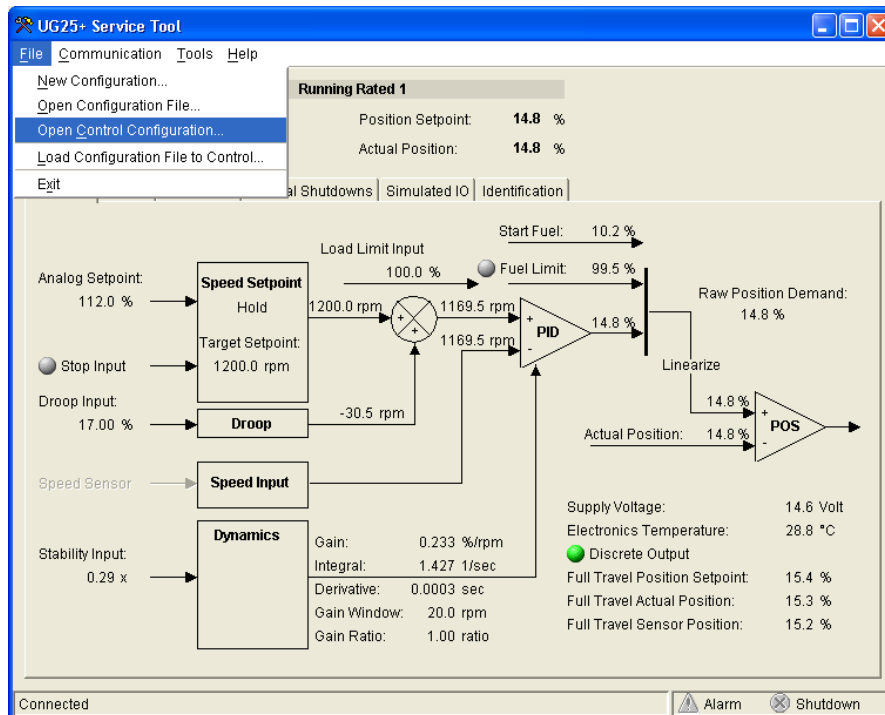
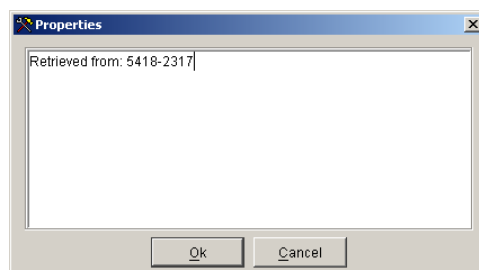


Figure 6-1. Configuration Selection Options

Application File Data

The OEM or customer can save configuration file specific data with the service tool by selecting Properties under the File menu pull down. This is a text field and can be used to store data such as:

- Customer
- Engine Type
- Application Type
- Notes



Configuration Parameters

There are 5 different screens that display/set the configuration settings in the UG-25⁺ Speed Controller; Overview, Set Point, Fuel Limiting, Dynamics, and Security.

Overview Tab

The overview tab provides speed sensing and position controller configuration settings.

Configuration File Editor - Configuration1.cfg

File Help

Overview Setpoint Fuel Limiting Dynamics Security

Speed Input

Engine Type: ☐ 2 Stroke ☒ 4 Stroke

Speed Ratio (shaft / engine): ⚠ Review all speed related parameters after changing the Speed Ratio !

Number Of Cylinders:

Number Of Cylinders Averaged:

Start Settings

Start Fuel: ☐ One ☒ Two

Start Speed 1 Threshold*: rpm

Start Speed 2 Threshold*: rpm

Start Speed Hysteresis*: rpm

Actuator Ramp Rate: %/sec

Start Fuel 1: %

Start Fuel 2: %

Stop Speed Threshold*: rpm

Run Speed Threshold*: rpm

Start Target Speed: ☐ Ramp to Min ☒ Ramp to Rated

Start Target Speed Rate: rpm/sec

* Values are constrained by each other in increments of 8/SpeedRatio in the following order:
Start Speed Hysteresis, Start Speed 1, Start Speed 2, Stop Speed, Run Speed

Figure 6-2. Configuration Editor – OVERVIEW TAB

Speed Input Configuration Settings

Engine Type

Set to either 2-stroke or 4-stroke.

Speed Ratio (shaft to engine speed)

Set the ratio between UG-25⁺ shaft speed (governor speed) and actual engine speed. This parameter sets the relationship between the speed of the governor (UG-25⁺ shaft speed) and actual engine speed. When set to '1', all speed settings will be displayed in terms of governor shaft speed. Allowed values: 0.0625 – 50.

Number of Cylinders

Sets the number of cylinders.
Allowed values: 1 – 20.

**NOTE**

Allowed adjustment ranges are displayed in the lower left corner of the window when an adjustable parameter is selected.

Number of Cylinders Averaged

Sets the number of cylinders to be averaged by the speed sensing algorithm. This setting is used as a filter to minimize the effects of firing torsionals that occur normally in reciprocating engines. A lower value gives less filtering, producing higher steady-state speed variation but allowing a higher speed control gain setting for better transient response. A higher value produces less steady-state speed variation with correspondingly slower transient response. If unsure, set this to either '1' or half the 'Number of Cylinders' for a 4-stroke. On a 2-stroke engine, '1' or 'Number of Cylinders' are good choices.

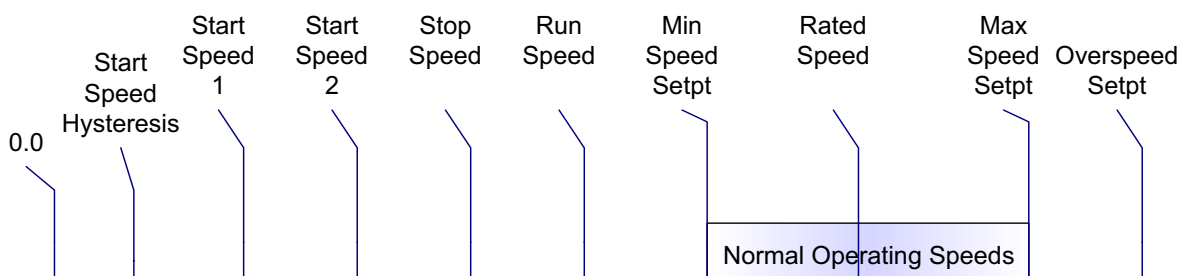
For uneven firing patterns, 'Number of Cylinders Averaged' should be selected to eliminate repeating torsionals. If cylinder firings are paired, 'Number of Cylinders Averaged' should also be paired (2, 4, 6, ...). If unsure, set to 'Number of Cylinders'.

Allowed values: 1 to 'Number of Cylinders'.

**NOTE**

Steam Turbine applications settings should be 2-stroke, 1:1.0 Speed Ratio, 1 cylinder, and 1 cylinder averaged. For these applications all configured and displayed speed values will be in terms of governor (shaft) speed, not engine speed.

The UG-25⁺ speed settings must follow the following general order.



Starting the Engine

The engine starting sequence will look like this, if no errors are detected:

While stopped, make sure the Run/Stop input is in the RUN position.. Start (crank) the engine. As the engine speed increases above the Start Speed 1 Threshold, the governor will go to the Start Fuel 1 position demand. If two start fuel positions are used, as the engine speed increases above the Start Speed 2 Threshold, the governor will go to the Start Fuel 2 position demand. At this point the governor is still running open loop, the speed control PID is not controlling to the governor position. Once the engine speed is above the run speed threshold, the governor will bumplessly switch from start fuel demand to the fuel demand from the speed PID. At this point the unit is in speed control and will control the engine to the speed set point. The speed set point will ramp up to the configured control speed, rated or min. From this point the set point can be adjusted as needed using either raise/lower commands or the analog speed set point.

If an error is detected, the control will go to the stopping state. Once the engine speed decreases to zero rpm, the unit will be in the stopped state.

Engine Start Settings



NOTE

All speed settings are in terms of engine speed and all position settings are in terms of percentage of full (42 degrees) shaft rotation.

Start Fuel Selection

Set to either one start fuel setting or 2 start fuel settings with a ramp between the settings. A single start fuel is suitable for most applications. With this configuration, the fuel demand immediately switches to the Start Fuel 1 setting when the engine speed has exceeded the Start1 Speed setting.

Dual start fuel configuration is appropriate for engines that need a rather high fuel setting to start the engine, but a much lower setting immediately thereafter to minimize speed overshoot, minimize black smoke, or to prevent an overspeed shutdown.

Start Speed 1 Threshold

Start Speed 1 Threshold is set below the starter speed. Once this threshold is exceeded, the control determines a start is in progress and opens the governor to the start fuel setting. At this point the governor state changes from 'Stopped' to 'Start Fuel 1'. Typical value is 64 rpm to detect engine cranking.

Allowed values: 0 – 'Stop Speed Threshold' but must be less than 'Start Speed 2 Threshold' (if used). Adjustment Increment: 8 grpm.

Start Speed Hysteresis

Hysteresis is provided for the start speed threshold to ensure that a normal amount of variance in engine speed while in the Start Fuel State does not cause the control to enter the Stopping state. After the control has reached the Start Fuel state, it will go to the Stopping state if engine speed drops below the (Start Speed 1 Threshold – Start Speed Hysteresis) value.

Allowed values: 50% of 'Start Speed 1 Threshold' to 'Start Speed 1 Threshold'. Adjustment Increment: 8 grpm.

Start Fuel 1

Specifies the maximum permitted shaft position when the governor state is 'Start Fuel 1'. Typical value is the same as the full load governor position.

Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Start Speed 2 Threshold

Specifies the speed at which the Governor State changes from 'start1' to 'start2.' Typical value is 50% of the lowest speed reference. Only displayed if two start fuel limits are configured.

Allowed values: Must be between 'Start Speed 1 Threshold' and the 'Stop Speed Threshold'. Adjustment Increment: 8 grpm.

Start Fuel 2

Specifies the maximum permitted shaft position when the governor state is 'Start Fuel 2'. Only displayed if two start fuel limits are configured.

Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Governor Ramp Rate

Specifies the rate, in %/sec, the control will move the governor position from the Start Fuel 1 to the Start Fuel 2 position once the speed exceeds the Start Speed 2 Threshold. If the ramp rate is set to its maximum value, the change to the second start fuel setting is nearly instantaneous, essentially eliminating the ramp feature. Only displayed if two start fuel limits are configured.

Allowed values: 0.235 – 200 %/second

Stop Speed Threshold

Specifies the speed at which the Governor State changes from 'Stopping' to 'Stopped'. If the engine is stopped by a shutdown, the control will go to the Stopping state and the engine must stop before proceeding to any other state. If the engine is stopped by the Run Enable input, the control will again go to the Stopping state. In this case, however, if engine speed is still above the Stop Speed Threshold, making the Run Enable switch active again will allow the control to go directly back to the running state. Below the Stop Speed Threshold, the control will not allow the engine to restart.

Allowed values: Must be greater the 'Start Speed Threshold' and less than 'Run Speed Threshold'. Adjustment Increment: 8 grpm.

Run Speed Threshold

Specifies the speed at which the Governor State changes from 'Start Fuel' to 'running.' Typical value is 90% of the lowest speed reference. If the engine speed is above the Run Speed Threshold, the control will switch to one of the running states and start using the speed control to drive the governor position demand up to the configured Start Target Speed set point.

Allowed values: Must be greater the 'Stop Speed Threshold' and 'Min Speed Set Point'. Adjustment Increment: 8 grpm.

Start Target Speed selection

Sets the desired speed set point at the conclusion of the start sequence. The 2 options are either Rated Speed or Min Speed Set Point – both of these are set on the Set Point tab.

Start Target Speed Rate

Specifies the ramping rate for the speed set point from Run Speed up to the specified Start Target Speed set point. Allowed values: 1 – 1000 grpm/second.

Set Point Tab

The set point tab provides the speed set point configuration settings.

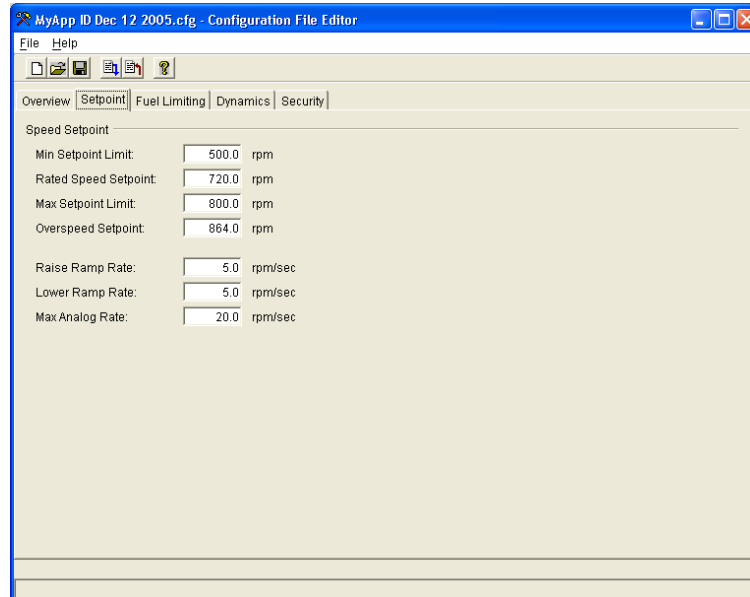


Figure 6-3. Configuration Editor– SETPOINT TAB

Min Set Point Limit

Specifies the lowest desired speed set point possible with the Raise/Lower Adjust or Analog functions. Allowed values: From 'Run Speed' to the 'Rated Speed Set Point'.

Rated Speed Set Point

Sets the Rated Speed Set Point. Allowed values: From the 'Min Set Point Limit' up to the 'Max Set Point Limit'.

Max Set Point Limit

Specifies the highest desired speed set point possible with the Raise/Lower Adjust or Analog functions. Allowed values: From the 'Rated Speed Set Point' up to 'Overspeed Threshold', but must be less than the factory set/installed pump speed limitation. Existing pump speed limits are 1500 and 1100 rpm (shaft), but are subject to change.

Overspeed Threshold

Specifies the speed level that will trigger an overspeed shutdown fault. Allowed values: From the 'Max Set Point Limit' up to a max shaft speed of 4080 rpm

Raise Ramp Rate

Specifies the ramping rate for the speed set point Raise function. Allowed values: 1 – 1000 grpm/second.

Lower Ramp Rate

Specifies the ramping rate for the speed set point Lower function. Allowed values: 1 – 1000 grpm/second.

Max Analog Rate

Specifies the maximum ramping rates allowed for the speed set point Analog adjust function. Allowed values: 1 – 1000 grpm/second

**NOTE**

It is recommended the Max Analog Rate setting be set to a value that will prevent overshoot and possible overspeed on enabling of the Remote Input.

Fuel Limiting Tab

The fuel limiting tab provides run time and boost fuel limiting configuration settings.

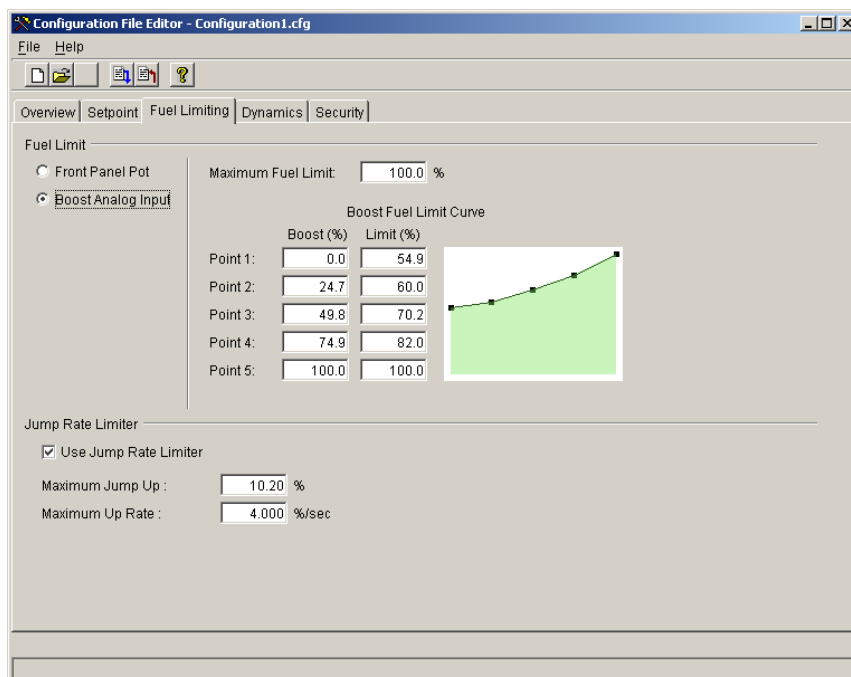


Figure 6-4. Configuration Editor– Fuel Limiting Tab

Fuel Limiting Settings

Maximum Fuel Limit

Sets the maximum permitted shaft position. Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Fuel Limit Input Selection

Selects between the Boost Input Curve (analog input) vs front panel Load Limit potentiometer. This selection must be done in conjunction with the wiring option to properly select the desired input (see Load Limit/Boost Pressure Select discrete input in the wiring section).

Boost Fuel Limiting Curve Settings

These settings are only displayed when the Fuel Limit Input selection is set to 'Boost Analog Input'.

Boost (%)

Fuel limit curve inputs. Allowed values: 0 –100 % of full analog input range (4 mA is 0% and 20 mA is 100%). Each point [5] must be larger than the previous and less than the next value, in increments of 1.2 percent.

Limit (%)

Fuel Limit curve outputs. Sets the maximum governor positions [5] based on the boost analog input. Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Jump Rate Limiter Settings

The Jump Rate Limiter can be used limit the increasing fuel position output to prevent excessive emissions.

Use Jump Rate Limiter

Enables or disables the jump rate limiter function. If used, “jump up” and “up rate” limit are available.

Max Jump Up

Specifies the ramping rate for the speed set point Raise function. These settings are only displayed when the ‘Use Jump Rate Limiter’ option is selected. Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Max Up Rate

Specifies the max governor output rate in the increasing direction. ramping rate for the speed set point Lower function. These settings are only displayed when the ‘Use Jump Rate Limiter’ option is selected. Allowed values: 0.235 – 200 %/second.

Dynamics Tab

The dynamics tab provides speed controller dynamics settings. The dynamic settings can also be adjusted from the Edit Speed Dynamics screen during run-time.

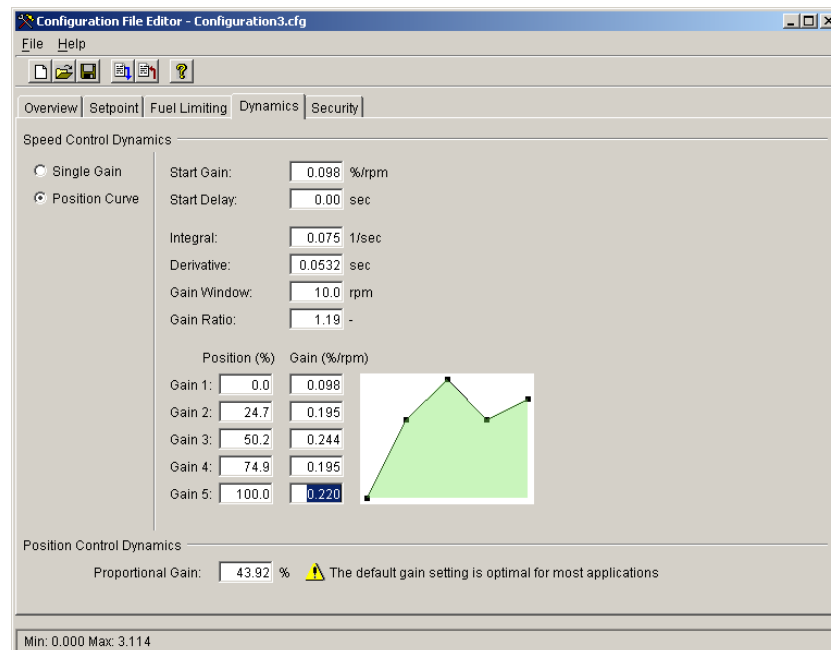


Figure 6-5. Configuration Editor–Dynamics Tab

Speed Controller Dynamics Settings

Mode

Sets the functional mode for the P-gain term of the PID. This can be individually set for both sets of dynamics, if used.

Rated—a single speed gain term is used which remains constant and does not vary with engine speed or load. These are simple dynamics that suit most constant speed applications. Rated dynamics are typically used on engines that operate continuously at rated speed or on variable speed engines that tend to be stable at all speeds with constant dynamic settings.

Rated Curve—the gain term will be adjusted based on governor position using a 5-pt curve. Fuel demand is roughly proportional to load but not necessarily in a linear manner. A 5-breakpoint gain curve is provided to map gain versus fuel demand. Gain is applied linearly between breakpoints. A common gain setting is also provided to shift all gain curve gains higher or lower. This gain curve is particularly useful for non-linear fuel systems (for example, intake butterfly valves).

Start Gain

Sets the gain to be used during a start. Typically this is set to a lower than normal gain value. To disable the Start Gain, set the Start Gain Timer to zero. Allowed values: 0 – 3.114 %/rpm.

Start Gain Timer

Sets the number of seconds the Start Gain is used during a start. To disable the Start Gain, set the Timer to zero. Allowed values: 0 – 300 seconds.

Integral

Speed control nominal PID integral term in repeats per second. The actual 'used gain' is manipulated by the front panel Stability pot, and will be equal to the nominal setting when the pot is in mid position. Allowed values: 0 – 19.15 repeats/second.

Derivative

Speed control PID derivative term in seconds. Allowed values: 0 – 0.1036 seconds.

Gain Window

Speed control PID gain window, in rpm. When the speed error is greater than the window, the proportional Gain is multiplied by the Gain Ratio. Allowed values: 0 – 255 grpm.

Gain Ratio

Speed control PID gain ratio. When the speed error is greater than the window, the proportional Gain is multiplied by the Gain Ratio. Allowed values: 1 – 15.

Proportional Gain

Speed control nominal PID proportional gain term. This setting is only displayed when 'Rated' dynamics mode is selected. The actual 'used gain' is manipulated by the front panel Stability pot, and will be equal to the nominal setting when the pot is in mid position. Allowed values: 0 – 3.114 %/grpm.

Position (%)

Position breakpoints for the gain curve. These settings are only displayed when 'Rated Curve' is selected. Allowed values: Each point [5] must be larger than the previous and less than the next value, in increments of 0.4 percent.

Gain (%/rpm)

Sets the nominal PID proportional gain value [5] based on the position. These settings are only displayed when 'Rated Curve' is selected. The actual 'used gain' is manipulated by the front panel Stability pot, and will be equal to the nominal setting when the pot is in mid position. Allowed values: 0 – 3.114 %/rpm.

Position Controller Dynamics – Proportional Gain (%)

Sets the Position Controller PID proportional gain value. Note that the default gain setting is optimal for most applications. Increased gain corresponds to increased PID output (higher proportional = faster response). This setting is not affected by the front panel Stability pot. Allowed values: 25.88 – 45.88 %.

**NOTE**

If the dynamics curve inputs are changed, control power must be cycled.

Security Tab

The security tab provides the security configuration settings. To use any security, the Read Configuration security must be configured for use. Once selected, the Security Password must be set (figure 6-7). One common password is used for all security selections. The password entry is prompted (figure 6-8) whenever a secured function is selected by the user.

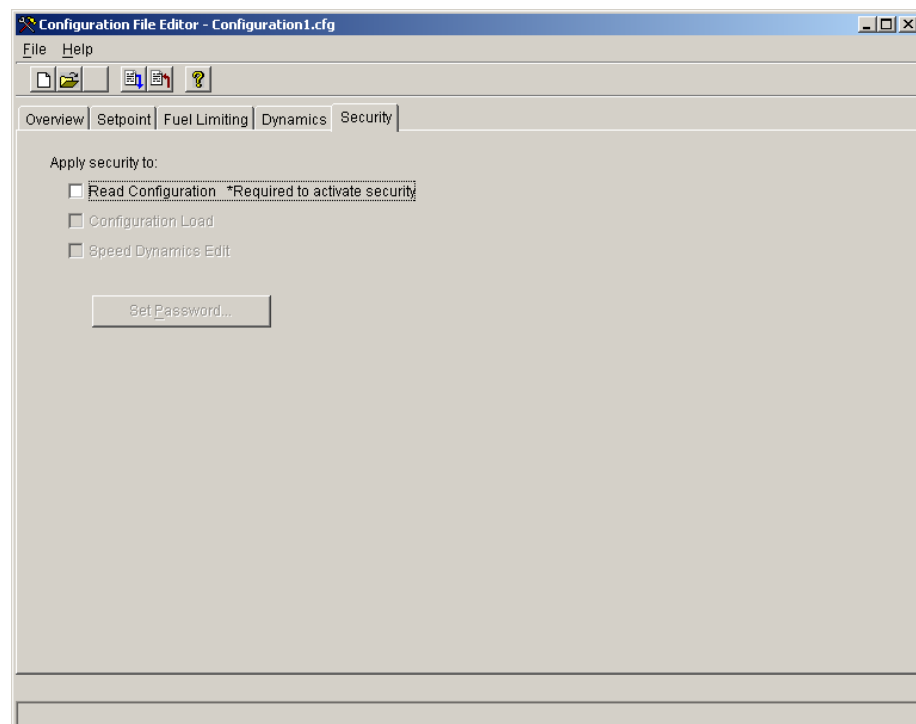


Figure 6-6. Configuration Editor– Security Tab

Security Configurations

All checked features will have the security password enforced prior to allowing the function. Unchecked features will not be prompted with a password.

Read Configuration

When checked, requires a password before the configuration can be read from the UG-25⁺ control (protects Open From Control execution).

Configuration Load

When checked, requires a password before a configuration can be loaded into the UG-25⁺ control (protects Load to Control execution).

Speed Dynamics Edit

When checked, requires a password before allowing tuning to the speed PID (protects Edit Speed Dynamics screen).

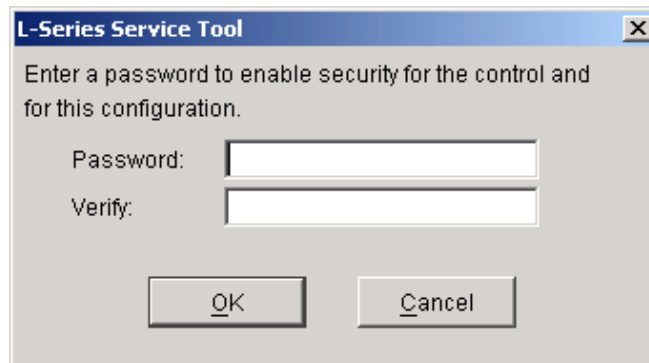


Figure 6-7. Security tab Set Password Pop-up

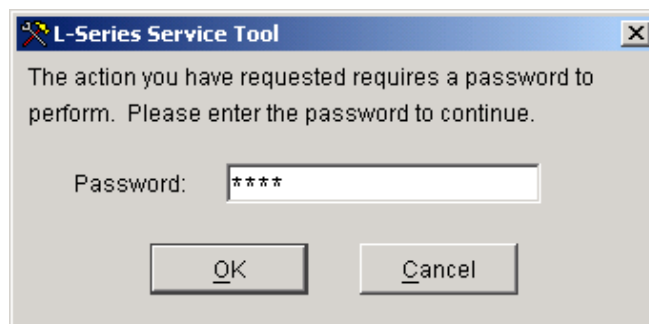
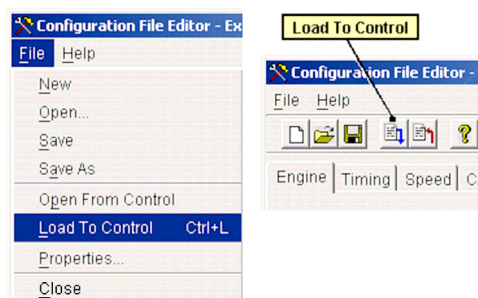


Figure 6-8. Password Entry Prompt

Loading the Configuration (Save)

Select the File/'Load to Control' option from the menu or Blue Arrow icon on the Configuration Editor to load the changes into the control. The UG-25⁺ speed must be zero prior to allowing a 'Load' command. This feature can be optionally password protected.



Load Configuration File to Control

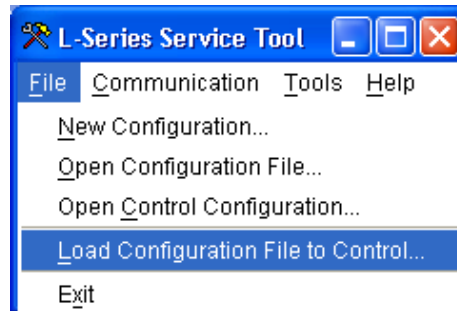


Figure 6-9. Direct Load of Configuration File

The 'Load Configuration File to Control' option under the Run screen File menu allows loading a configuration file to a control without opening it. Thus, a password protected configuration file can be downloaded without entering the password while preserving the configuration's security.

If the control that is being downloaded to already contains a configuration with password protection enabled for configuration loads, that password is still required.

Configuration Checks

Whenever a configuration is saved or loaded to the control, some basic checks are performed. This check cannot determine if the values are realistic, but it makes sure that values are loaded into the required parameters. If an error is found, the Service Tool will not allow the load or save function to be performed until the error is corrected.

1. **Speed range exceeds governor limits (Max Set Point Limit setting).** The setting for Max Set Point Limit (on the Set Point tab) must be less than the Max Pump Speed Limit or this Configuration Error message is displayed. Since the Pump Size is based on the installed UG-25⁺ pump size, this check is only done when a Load to Control is selected.
2. **Run Speed > Min Speed Setpt.** The setting for Run Speed Threshold (Overview tab) must be less than the Min Set Point Limit (Set Point tab) or this configuration error message is displayed.
3. **Speed sensing/filtering limits exceeded.** Try reducing the Number of Cylinders Averaged. This error message is displayed when the settings exceed control limits. The limit is determined by Service Tool calculations and based on the speed input settings of stroke, gear ratio, number of cylinders and number of cylinders averaged.

Chapter 7. Speed PID Tuning

Introduction

The UG-25⁺ is configured using the Service Tool, refer to chapter 5 for Service Tool installation and connection instructions. This chapter covers the process of tuning and servicing the control via the UG-25⁺ Service Tool. It is assumed that the control has already been installed on the engine.

An application requires the following setup steps. In many applications these steps have already been performed by the OEM.
Configure the UG-25⁺ control (configuration is covered in chapter 6).
Tune the Speed controller loop PID.

In addition, jump and rate limit settings and the position controller proportional gain term can be adjusted to meet application requirements.

**NOTE**

Setup and tuning features can be individually password protected for security purposes. If security is applied, these features will not be accessible without the password.

**NOTE**

Many applications are delivered pre-configured, calibrated, and tuned. For most applications, the default gains do not need to be changed.

**WARNING—TRAINED PERSONNEL**

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

**CAUTION—SERVICE TOOL PROGRAMMING HARNESS**

When the Service Tool programming harness is connected, the speed set point (raise/lower/analog) and load limit functions are no longer available. However, simulation of these functions is provided in the Service Tool software.

The Service Tool can be used to tune the Speed PID or to just trend/monitor the speed PID output. The Speed PID Dynamics screen (figure 7-1) is opened by selecting 'Edit Speed Dynamics' under the 'Tools' menu.

Pressing the Properties button pops open the Properties Window. From this window the user can adjust the trending window properties including the speed range, update rate and display range.

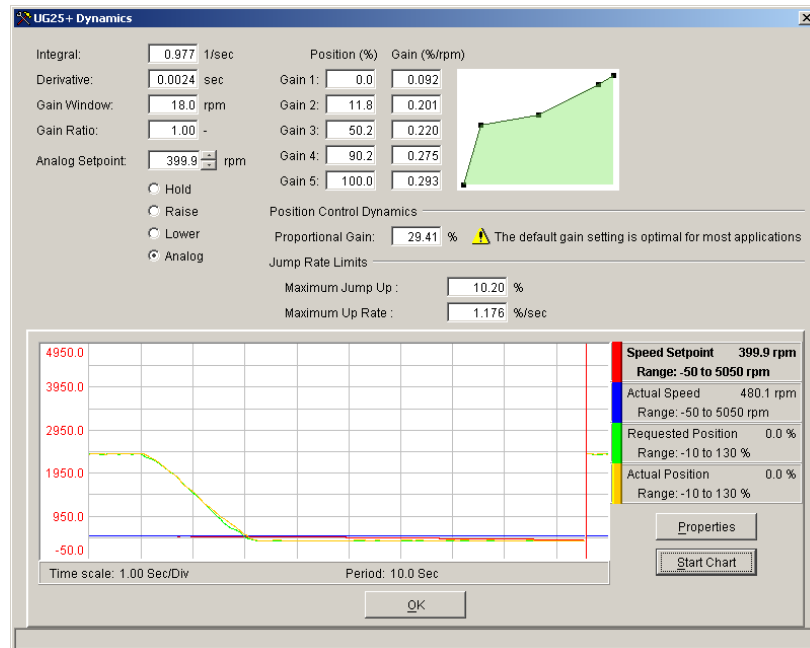


Figure 7-1a. Service Tool – Speed Dynamics Position Curve

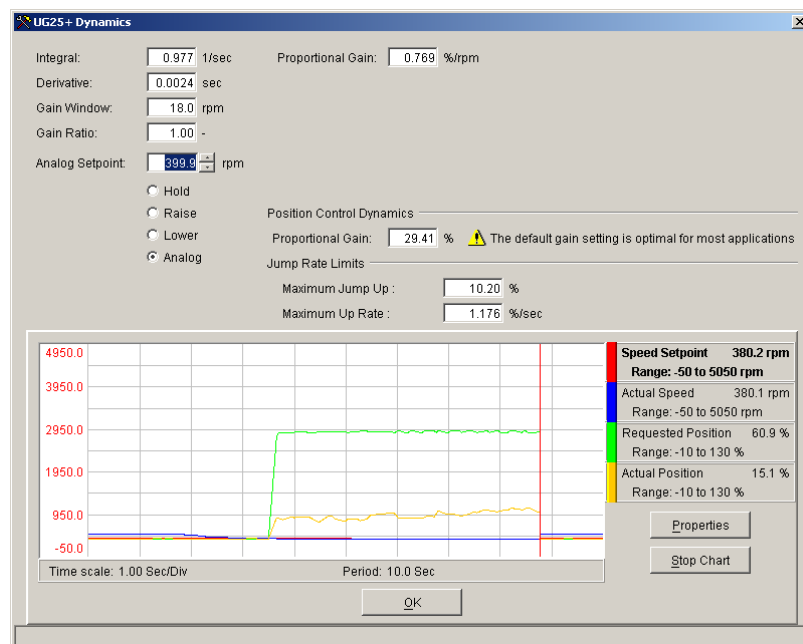


Figure 7-1b. Service Tool – Speed Dynamics Single Gain

Adjusting Trend Settings

Pressing the Properties button pops open the Properties Window (figure 7-2). From this window the user can adjust the trending window properties including the update rate and display range.

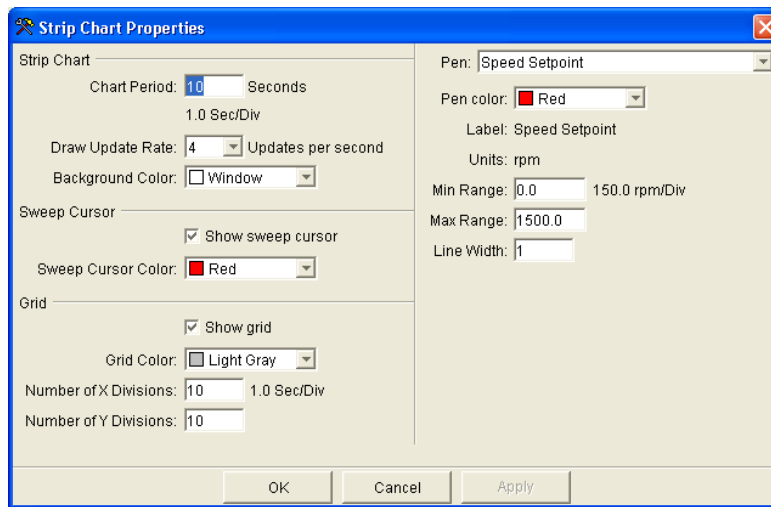


Figure 7-2. Service Tool – PID Tuning Properties Window

Each trend line, called pens, can be individually modified from the Properties window. To change the properties of a trend, select the pen from the drop-down window. The color, range, and line width of each pen can be modified.

Speed PID Dynamic Settings

The Speed loop utilizes a PID controller. The response of this control loop can be adjusted for optimum response, however it is important to understand what a PID controller is and the effect each controller adjustment has on the controller response. Proportional gain (P), integral gain (I), and derivative (D) are the adjustable and interacting parameters used to match the response of the control loop with the response of the system.

Proportional Control

Proportional response is directly proportional to a process change.

Analogy: Setting hand throttle to keep constant speed on straight and level.

Proportional control (using the same analogy) results in a certain speed as long as the car is not subjected to any load change such as a hill. If a throttle is set to any particular setting, the speed of the car will remain constant as long as the car remains straight and level. If the car goes up a hill, it will slow down. Of course, going down a hill the car would gain speed.

Integral Control

Integral compensates for process and set point load changes.

Analogy: Cruise control maintains constant speed regardless of hills.

Integral, sometimes called reset, provides additional action to the original proportional response as long as the process variable remains away from the set point. Integral is a function of the magnitude and duration of the deviation. In this analogy the reset response would keep the car speed constant regardless of the terrain.

Derivative

Derivative provides a temporary over-correction to compensate for long transfer lags and reduce stabilization time on process upsets (momentary disturbances).

Analogy: Accelerating into high speed lane with merging traffic.

Derivative, sometimes called "preact" or "rate", is very difficult to draw an accurate analogy to, because the action takes place only when the process changes and is directly related to the speed at which the process changes. Merging into high speed traffic of a freeway from an "on" ramp is no easy task and requires accelerated correction (temporary overcorrection) in both increasing and decreasing directions. The application of brakes to fall behind the car in the first continuous lane or passing gear to get ahead of the car in the first continuous lane is derivative action.

Proportional Response

The amount of controller change is directly related to the process change and the Proportional gain setting on the controller; Controller output change is Proportional to the process change. If there is no process change, there is no change in output from the controller (or valve change) regardless of the deviation. This results in an undesired offset between the original desired Set Point and the resulting drop in the Control Point.

Since Proportional gain is adjusted to produce (only) the proper stability of a process, do not continue increasing its effect to correct offset conditions. The amount of stability and offset is directly related to the setting of the Proportional setting. Stability is of course also affected by the stability of the process. In essence, the amount of output from the controller due to the Proportional setting is from the error. If there is no error, then there is no Proportional effect.

Integral Response

In the UG-25⁺, integral gain is in units of repeats per second (or Reset Rate). Therefore, a high amount of Integral gain (high number) would result in a large amount of Reset action. Conversely, a low Integral gain (low number) would result in a slower reset action.

Integral response is provided to eliminate the offset that resulted from straight Proportional control. The Integral (or Reset) action is a function of both time and magnitude of the deviation. As long as an offset condition (due to load changes) exists, Integral action is taking place.

The amount of Integral action is a function of four things:

1. The magnitude of the deviation.
2. The duration of the deviation.
3. The Proportional gain setting.
4. The Integral setting.

Derivative Response

In a process control loop the Derivative action is directly related to how fast the process changes (rate of change). If the process change is slow then the Derivative action is proportional to that rate of change. Derivative acts by advancing the Proportional action. Derivative acts at the start of the process change, when the process changes its rate and when the process stops its change.

Derivative action takes place at only three times:

1. When the process starts to change.
2. When the rate of change takes place in the process.
3. When the process stops changing.

The net result of Derivative action is to oppose any process change and combined with Proportional action to reduce stabilization time in returning the process to the set point after an upset. Derivative will not remove offset.

Derivative provides a temporary over-correction to compensate for long transfer lags and reduce stabilization time on process upsets (momentary disturbances).

Another possible use of the derivative adjustment is to reconfigure the controller from a PID to a PI controller. This is done by adjusting the derivative term to zero.

General Field Tuning Guidelines

Best results are obtained when the adjustment (tuning) is done systematically. Prior training and experience in controller tuning are desirable for effective application of this procedure. The settings made for one operating set of conditions may result in excessive cycling or highly damped response at some other operating condition. The tuning procedure should be applied under the most difficult operating conditions to assure conservative settings over the normal operating range. The UG-25⁺ can be configured for a 5-point position curve, providing greater flexibility in dynamics settings over this range.

It is good practice to keep the average of the set point changes near the normal set point of the process to avoid excessive departure from normal operating level. After each set point change, allow sufficient time to observe the effect of the last adjustment. It is wise to wait until approximately 90% of the change has been completed.

Speed Set Point Adjustments

While the Service Tool is connected, all normal means of adjusting the speed set point (raise/lower, analog) are disabled. To compensate for this loss of functionality, the Speed set point can be adjusted from the Speed PID tuning screen (figure 7-1) or from the Simulated IO tab (figure 7-3).



Figure 7-3. Speed Set Point Adjustment

The default set point mode is 'Hold', which maintains a constant set point. When 'Raise' or 'Lower' is selected, the speed set point will increase at the Raise Ramp Rate or Lower Ramp Rate, respectively. When 'Analog' is selected, the set point moves to the selected Analog Set Point at the Max Analog Rate. The analog set point tracks the speed set point to ensure bumpless mode transfers. All adjustments are limited between the normal operating range (Min Set Point Limit to Max Set Point Limit). Refer to the Speed Set Point settings in Chapter 6-Configuration.

Front-panel Stability Pot

The front panel stability pot is active at all times and provides a multiplier on the Gain (P) and Integral (I) settings. When the pot is a mid-position, the multiplier is '1' and the gains will be at their nominal configured values (see Dynamics in chapter 6).

The Overview tab of the Service Tool provides a display of the actual "used" values of the controller (see figure 7-4). The displayed values take into account the Stability pot input and provides an indication of the gain curve value, when configured.

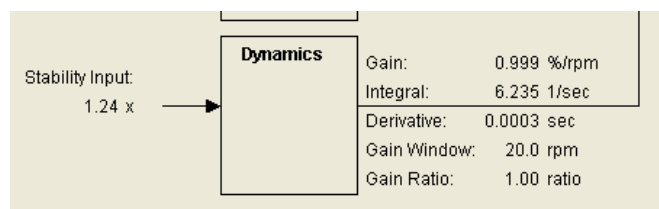


Figure 7-4. Actual PID Dynamics on Overview Tab

My System is Unstable

If the system is unstable, make sure the speed PID dynamics is the cause. This can be checked by reducing the load limiter until it has control of the governor output. If the governor is causing the oscillation, time the oscillation cycle time. A rule-of-thumb is, if the system's oscillation cycle time is less than 1 second reduce the Proportional gain term. A rule-of-thumb is, if the system's oscillation cycle time is greater the 1 second reduce the Integral gain term (proportional gain may need to be increased also).

On an initial startup with the UG-25⁺, all PID dynamic gain terms will require adjustment to match the PID response to that of the control loop.

The proportional gain setting of the position controller is also available for adjustment on the dynamics tuning window. Reducing this gain will lower the overall control bandwidth. Lowering this gain term in some systems can reduce the nervousness of the output shaft. The nominal gains settings are optimal for most applications but if the speed controller dynamic adjustments do not achieve the desired results, modifying this setting may help.

Chapter 8.

Troubleshooting

Introduction

This chapter presents several broad categories of application failures typically experienced in the field, possible causes, and some tests used to verify the causes. Because the exact failure experienced in the field is the product of the mechanical/electrical failure combined with the configuration file resident in the control, it is left as the OEM's responsibility to create a more detailed troubleshooting chart for the end user. Ideally, this end-user troubleshooting chart will contain information about mechanical, electrical, engine, and load failures in addition to the possible governor failures. For more detailed information about governor system failure modes and effects, contact Woodward for a copy of the system DFMEA.

The troubleshooting scenarios listed below assume that the end user has a digital multimeter at his disposal for testing voltages and checking continuity, and assume that the application has been engineered and tested thoroughly.

There are four parts to the troubleshooting section:

- General Troubleshooting
- Engine/Generator Troubleshooting
- Troubleshooting Alarm/Shutdown Diagnostic Flags
- Input/Output (I/O) Troubleshooting



WARNING—GOOD JUDGMENT REQUIRED

The actions described in this troubleshooting section are not always appropriate in every situation. Always make sure that any action taken will not result in loss of equipment, personal injury, or loss of life.



WARNING—OVERSPEED PROTECTION

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An over temperature or over pressure shutdown device may also be needed for safety, as appropriate.



WARNING—NOISE

The UG-25⁺ is used on prime movers that typically have a high noise level. Always use appropriate hearing protection while working around the UG-25⁺.



WARNING—WIRING

The UG-25⁺ wiring must be in accordance with North American Class I, Division 2 or Zone 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. By making these checks appropriate to your engine/turbine before contacting Woodward for technical assistance, your system problems can be more quickly and accurately assessed.

- Valves
- Is the wiring correct?
- Is the shaft direction correct?
- Is the direction of the stroke correct?
- Is the direction of the failsafe shutdown correct?
- Does the output shaft move through its proper stroke smoothly?
- Does the output travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the output fully seat (close)?
- Does the output fully open?

Oil

Keep the governor oil level to the mark on the oil sight glass with the unit operating. Dirty oil causes most governor problems. Use clean, new, or filtered oil. Oil containers used must be perfectly clean. Oil contaminated with water breaks down rapidly, causing foaming, and corrodes internal governor parts.

Preliminary Inspection

Governor problems are usually revealed in speed variations of the prime mover, but it does not necessarily follow that such variations are caused by the governor. When improper speed variations appear, the following procedure should be performed:

1. Check the load to be sure the speed changes are not the result of load changes beyond the capacity of the prime mover.
2. Check engine operation to be sure all cylinders are firing properly and that the fuel injectors are in good operating condition and properly calibrated.
3. Check the linkage between the governor and fuel racks or valve. There must be no binding or lost motion.
4. Check that the oil is clean and oil level is correct at operating temperature. The source of most problems in any hydraulic governor stems from dirty oil. Grit and other impurities can be introduced into the governor with the oil, or form when the oil begins to break down (oxidize) or becomes sludgy.

The internal moving parts are continually lubricated by the oil within the unit. Valves, pistons, and plungers will stick and even “freeze” in their bores, due to grit and impurities in the oil.

If this is the case, erratic operation and poor response can be corrected (if wear is not excessive) by flushing the unit with fuel oil or kerosene.

The use of commercial solvents is not recommended as they may damage seals or gaskets.

Change the oil and flush the governor twice a year if possible.

To change oil, remove the drain plug and drain out the old oil. Flush the governor by filling it with fuel oil, and with the prime mover running at low speed, cycle the governor by opening the needle valve two or three turns. Let the governor hunt for a minute or two, then stop the engine and drain the governor. Flush the governor once again. Refill the governor with oil (see Chapter 2, Oil Supply).

Restart the engine and reset the compensation adjustment and needle valve.

5. Check that the drive to the governor is correctly aligned and free of roughness, side loading, and excessive backlash.

Engine/Generator Troubleshooting

Problem	Possible Cause	Suggested Test/Correction
Engine hunts or surges	The problem may be originating in the governor or prime mover.	Block the throttle, fuel racks, or steam valve in the direction of increase fuel. (Never block the governor output shaft in the direction that would prevent a complete shutdown.) The same blocking action can be performed by using the load limit knob on the governor panel. If hunting and/or surging continues while the governor output shaft is blocked, the problem is in the prime mover. If, after removing the block, hunting and/or surging starts again, the problem can be in the governor or in the prime mover. Go through the dynamics adjustment procedure for the governor (see Chapter 7). If the problem is still there, replace the governor with a replacement governor. Go through the dynamics adjustment procedure for the replacement governor. If the hunting and/or surging continues, the problem is in the prime mover.
	Controller gain adjustments incorrect.	Adjust the gain settings using the Service Tool (see Chapter 7).
	Oil varnish, which causes sticking of parts.	Add oil to the mark on oil sight glass. If oil level decreases and no external oil leaks can be seen on the governor, check the drive shaft for oil leak. If foaming continues, drain oil and refill using a different type oil.
	Dirty oil (sludge) in governor.	Drain oil, clean governor, and refill.
	Lost motion in engine linkage or fuel pumps.	Repair linkage and/or pumps. Repair governor.
	Binding in engine-to-governor linkage or fuel pumps.	Repair and realign linkage and/or pumps.
	Governor output shaft travel too short to provide full fuel.	Adjust travel until proper travel is obtained.
	Low oil pressure.	Return governor to factory for repair.
	Power piston is sticking.	Check for side play or binding on output shaft.

Problem	Possible Cause	Suggested Test/Correction
Engine hunts or surges (continued)	Fuel linkage incorrectly set. This might occur if the governor has been changed or removed and replaced. Relationship of governor travel to power output of engine should be linear.	Rework or reset the linkage from governor to unit to obtain the linear relationship.
	Faulty linkage.	Linkage should be free of binding and lost motion throughout service life of unit. Check yield links, shutdown arrangements, etc, to be sure that prime mover torque changes for very small increments of governor output shaft travel. Stability and good steady-state performance will suffer unless this condition is met.
	Incorrect non-linear relationship between governor travel and power output of the prime mover. Engine may hunt with light loads and be stable with a heavy load.	Adjust linkage from governor to gas valve to obtain linear relationship between governor travel and engine output. See Figures 2-3 and 2-4. Also, see application note 50516.
	Gas or steam pressure too high.	Adjust gas or steam pressure.
	Engine misfiring (bad fuel injector or low pilot fuel on dual fuel engine).	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.
	Governor dynamics/stability issue.	See Engine Unstable section below.
	Governor worn.	Return governor to factory for repair.
Jiggle at governor output shaft	Rough engine drive or governor drive.	Inspect drive mechanism. a. Check alignment of gears. b. Inspect for rough gear teeth, eccentric gears, or excessive backlash in gear train. c. Check gear keys and nuts or set screws holding drive gears to shafts. d. Check for bent drive shaft. e. Check serrated or spline coupling for wear and alignment. f. Tighten chain between crankshaft and camshaft (if used). g. Check engine vibration damper (if used).
	Governor is not aligned properly.	Loosen governor mounting screws and move the governor slightly on its mounting pad to align the drive shaft with its coupling.
	Governor dynamics/stability issue.	See Engine Unstable section below.
Engine does not start	Stuck throttle/frozen shaft	Move throttle by hand. Assess smoothness, friction, and return spring force.
	Power not applied to control	Test for +18-32 Vdc between input power pin and ground pin.
	No configuration or incorrect configuration in controller.	Using Service Tool, read configuration from controller and evaluate parameters for correction.
	Fault detected in controller.	Using Service Tool, read faults from controller. Verify/correct any shutdown conditions (see fault troubleshooting below).

Problem	Possible Cause	Suggested Test/Correction
The governor is not opening the fuel control valve during engine cranking.	The control has detected a shutdown situation and has not been reset.	Reset the control by cycling power to the control or hitting reset on the Service Tool, (see fault troubleshooting below).
	There is no power supplied to the control.	Check fuse, wiring, and battery voltage.
	The control does not read any speed. Speed sensor defect, wiring defect, or incorrect speed sensor installation.	Read speed on the Service Tool to verify the governor detected speed. If incorrect, check speed input configuration settings.
	The control reads an actual engine speed below the start speed threshold.	Start speed is set too high. Lower start speed threshold.
	The Start fuel 1 and or 2 setup is incorrectly set to zero position.	Set up the Start Fuel to the correct value for this engine.
	Load limit pot not working.	Check voltage at pin 6 and verify voltage changes with pot position Verify load limit values with service tool
	Load limit analog input fault.	Verify that boost input selector wire is connected to ground Check voltage at pin 6 and verify voltage changes with analog input Verify load limit values with service tool
The engine will not go to rated speed.	The Control is not configured for Ramp To Rated operation.	Configure the Control for Ramp To Rated (operation if that is the correct operation mode).
	Droop pot not working.	Check voltage at pin 10 and verify voltage changes with pot position
	Wiring fault in analog speed set point.	Verify analog speed setting input is selected and wired correctly
The engine will not raise the speed set point.	Analog set point mode is active.	Check Raise/Lower Enabled LED on Front Panel. Raise and lower commands are not functional when Analog mode is active.
	The Raise input wiring is defective.	See Service Tool overview screen for input open/closed status. Check wiring.
The engine will not lower the speed set point.	Analog set point mode is active.	Check Raise/Lower Enabled LED on Front Panel. Raise and lower commands are not functional when Analog mode is active.
	The Lower input wiring is defective.	See Service Tool overview screen for input open/closed status. Check wiring.

Problem	Possible Cause	Suggested Test/Correction
Engine unstable	Improperly tuned dynamics.	Using Service Tool, tune the speed dynamics. Turn the front panel Stability pot in the CCW direction to reduce the gains.
	If analog mode is active, device sending analog command is sending oscillating signal.	Measure input signals.
	Stability pot fault.	Check voltage at pin 8 and verify voltage changes with pot position.
	If analog mode is active, device sending analog command is sending oscillating signal.	Measure input signal. Verify signal using Service Tool.
Poor frequency control	Improperly tuned dynamics.	Using Service Tool, tune the dynamics. Turn the front panel Stability pot in the CW direction to increase the gains.
	Output speed not at set point.	Verify that linkage is free. Verify that load limit is not active.
Unable to develop full power	Non-indexed linkage slipped on shaft.	Manually verify full travel of throttle plate.
	Fault detected in controller.	Using Service Tool, view status of fault codes. Take appropriate action for active faults.
Discrete output not working	Wiring fault.	Check the wiring leading to pin 9 for open connections or misconnections. Verify that pin 9 is not connected directly to input power or ground.
Service Tool not communicating—'Not Connected' status indicated	Wiring fault.	Check AUX3 and AUX4 for loose or mis-connected connections.
	The Service tool is disconnected.	Verify harness setup and connections (see Chapter 4)
	The wrong communication port has been selected.	Check that Service Tool is running. Verify the port setting is correct. Check fuse, wiring, and battery voltage. Connect the service tool by using the connect menu.
Service Tool not communicating—'Error message displayed on PC when trying to connect	Old version of Service Tool or file corruption or bad install.	Re-install Service Tool, get the latest version from the Woodward web site (www.woodward.com)
Service Tool will not accept password	Caps Lock is on.	Password is case sensitive, make sure you enter the password correctly using upper and lower case. If password is lost contact the OEM for retrieval.

Troubleshooting Alarm and Shutdown Faults

Shutdowns

Error Flag	Description	Possible Source	Possible Action
Overspeed	This diagnostic flag will be set if the actual engine speed is higher than the overspeed threshold.	The overspeed parameter has not been set. Engine dynamics are set up too slow for a sudden load reject. The governor is not capable of closing the fuel control valve (max torque). The fuel control valve is jammed or stuck. The governor is set up incorrectly. Zero percent position will not completely close the fuel valve. The linkage is moved or disconnected. The engine is not responding correctly. Speed input incorrectly configured.	Set the correct overspeed value. Increase the gains, decrease gain window, or increase gain ratio. Check the torque needed to close the fuel valve against the available torque. Fix or replace valve. Fix or replace linkage. 0% must close fuel valve. Fix or replace linkage. Check with the engine troubleshooting manual. Check speed input and speed ratio configuration settings using the service tool.
Loss of Speed Input	This diagnostic flag will be set if the speed sensor input pulses have not been detected.	Damaged, loss of speed probe or wiring. Damaged or loss connector. Speed input incorrectly configured.	Fix wiring. Return to replace connector or speed probe. Check speed input and speed ratio configuration settings using the service tool.
Stop Command	A shutdown (stop) command is issued.	Stop command is still active. Defective Front Panel interface or stuck Stop button. Speed did not go to zero.	Verify Stop input status using Service Tool. Check wiring for bad or loss connection. Check Stop button. Check wiring for bad or loss connection. A Stop command is latched-in until speed reaches zero.
Internal Shutdown	All internal shutdowns will set this flag.	The Control is defective.	Return unit to Woodward.

Alarms

Error Flag	Description	Possible Source	Possible Action
Watchdog Reset	If the watchdog has reset the Control, this flag will set.	Abnormal program execution. The software is disrupted by logic issue, EMI, or an internal component failure.	Cycle control power. Reset the error code and reset the stored errors. Return the unit to Woodward.
Brown Out Reset	The power up reset flag will be set every time power to the Control has been lost and is restored.	Normal power up of the Control. Loss of power or intermittent power supply wiring. Power supply wiring too long or too thin. Control will reset during transient power uses.	No action needed. Possibly reset control. Indication of a power source sag or slow voltage drop-out. Check wiring for bad or loss connection. Make sure wiring is of the correct thickness and length according to manual.
Temperature Sensor Failed	This error is set if the temperature inside the control is higher or lower than allowed by the specifications.	Control has been placed in an environment that is too hot or too cold. The internal temperature sensor is defective. This can be determined by checking the temperature of the unit and comparing this to the service tool value of the electronics temperature.	Lower temperature by adding cooling, heat shielding, moving the unit, etc. Increase temperature, if low, by adding heat. Verify Control detected temperature reading using Service Tool. Return unit to Woodward for repair.
Supply Voltage Failure	The power supply voltage is higher than the diagnostic limits. The Power supply voltage is lower than the diagnostic limits.	Bad or damaged battery. Defective battery charging system. Incorrect setting of power supply voltage level. Power supply wiring too long or too thin. Control will flag low voltage during higher power uses.	Replace battery. Fix battery charging system. Set correct voltage levels on power supply. Make sure wiring is of the correct thickness and length according to manual.
Overtemperature	High internal temperature.	Detection of high temperature .	Check ambient temperature around control. Verify Control detected temperature reading using Service Tool. If the temperatures seem normal, could indicate a problem with the internal temperature sensor.
Position Error	If the demanded position and the actual position are outside the configured limits.	Incorrect position PID control dynamics. Binding or excessive friction in the governor linkage, or stops are set inside the desired range of travel.	Check/tune position dynamics using the Service Tool. Check all mechanical linkages and stops.

Internal Shutdowns

Error Flag	Description	Possible Source	Possible Action
Position Sensor Failure	If the internal position sensor is outside the diagnostic limits.	Internal failure of position sensor.	Cycle power on the unit. Return unit to Woodward.
EEPROM Failure	The software can't write to the EEPROM. The software can't read from the EEPROM.	The control is experiencing problems with internal EEPROM.	Cycle power on the unit. Return unit to Woodward.

Electrical Troubleshooting Guide

Speed Input

If the speed input is not functioning properly, verify the following:

- Check the values seen by the UG-25⁺ using the Service Tool and verify that it matches the input signal.
- Check the wiring. Look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly as the demand source.
- Measure the input voltage and frequency (internal 20 tooth gear is driven off governor shaft). Pin J1-18-F3 (+) to Pin J1-18-B3 (–) or Pin J2-18-11 (+) to Pin J2-18-3 (–).

Analog Input

If an Analog Input is not functioning properly, verify the following:

- Measure the input. Refer to Analog Input in Specifications section for input impedances.
- Check the values seen by the UG-25⁺ using the Service Tool and verify that it matches the input signal.
- Verify that there are no or minimal ac components to the Analog Input signal. AC components can be caused by improper shielding.
- Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 V, look for loose connections and disconnected / misconnected cables/connections.

Discrete Input

If a discrete input is not functioning properly, verify the following:

- Measure the input voltage on the terminal block. Refer to Discrete Input in Specifications section for expected ON/OFF voltage levels.
- Check the status of the input from the Overview screen of the Service Tool.
- Check the wiring, looking for loose connections or misconnected cables.
- Verify the input is properly configured.

Alarm or Shutdown Conditions

If the UG-25⁺ control has any alarm or shutdown conditions, refer to Chapter 4 for details on the exact cause of the fault condition. The Service Tool must be used to determine the cause of any shutdown or alarm condition. Refer to the Troubleshooting of Alarm and Shutdown Faults earlier in this chapter.

Discrete Output

If the discrete output is not functioning properly, verify the following:

- Measure the output voltage on the terminal block. It should be in the range of 10–28 Vdc when the output is off/false. The voltage will be in this range only if all shutdowns are false. This can be verified through the Service Tool.
- Check the wiring, looking for loose connections or disconnected / misconnected cables.

Service Tool

If the service tool is not functioning properly, review the installation information in Chapter 4. Verify the following:

- Check the wiring, looking for loose connections or disconnected / misconnected cables (Programming harness or equivalent must be used).
- Check that Service Tool is running. Verify the Port setting is correct.
- Follow on-screen error messages. Re-install software as needed. The latest version of software is available for download from the Woodward web site (www.woodward.com).

Chapter 9. Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Replacement/Exchange

Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is also a flat rate structured program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

Return Shipment Authorization Label. To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

Flat Rate Repair

Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture

Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the item(s), attach a tag with the following information:

- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.



CAUTION—ELECTROSTATIC DISCHARGE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

Return Authorization Number

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the item(s) to be repaired. No work can be started until a purchase order is received.



NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

For assistance outside North America, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
India	+91 (129) 230 7111
Japan	+81 (476) 93-4661
The Netherlands	+31 (23) 5661111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (www.woodward.com) for the name of your nearest Woodward distributor or service facility.

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811

Toll-free Phone (in North America)—1 (800) 523-2831

Email—icinfo@woodward.com

Website—www.woodward.com

Technical Support is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Technical Support**.

Product Training is available at many of our worldwide locations (standard classes). We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Product Training**.

Field Service engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Technical Support**.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

General

Your Name _____
Site Location _____
Phone Number _____
Fax Number _____

Prime Mover Information

Engine/Turbine Model Number _____
Manufacturer _____
Number of Cylinders (if applicable) _____
Type of Fuel (gas, gaseous, steam, etc) _____
Rating _____
Application _____

Control/Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A.

Acronyms / Abbreviations

CCW	counterclockwise
CW	clockwise
CMRR	common-mode rejection ratio
CRC	cyclic redundancy count
DFMEA	Design Failure Modes and Effects Analysis
EMC	electro-magnetic compatibility
grpm	governor (shaft) speed in rpm
I/O	inputs/outputs
L-Series	Woodward electronic engine governor that contains both a rotary governor and a controller circuit board
O.D.	outside diameter
OEM	original equipment manufacturer
PID	proportional/integral/derivative
ppm	parts per million
TPS	travel position sensor
UG-25 ⁺	Universal Governor 25 ⁺

Appendix B.

UG-25⁺ Control Specifications

Governor

Power Supply	18 to 32 Vdc, dual inputs at 2.5 Amax. each
Power Consumption	Reverse polarity protection, 32 W max
Torque/Work Output (minimum)	37 N·m (27 lb-ft) stalled torque; 27 J (20 ft-lb) of work over 42 degrees
Max. Continuous Speed	1500 grpm max (small pump); 1200 grpm (large pump)
Ramp-up Rate	configurable from 0.2 to 200 grpm/sec
Steady State Speed Band	±0.25% of rated speed (under normal operating conditions)
Weight	26 kg (58 lb), dry weight
Customer Connector	30-pin Cinch connector (mating: 581-01-30-029S)

Governor Drive / Hydraulic System

Input Shaft Options	0.625 keyed drive shaft with 0.625-18 threads or 0.625-36 serrated
Output	42 degrees rotary
Terminal Shaft Options	0.625-36 serration
Drive Power Requirement	335 W (0.45 hp) max.
Internal Hydraulic Pressure	1034 kPa (150 psi)
Oil	Self-contained sump (2.2 qt/2.1 L capacity). See Woodward Manual 25071, Oils for Hydraulic Controls, for oil recommendations.
Drive Speed	Available with either high or low speed pump High-speed pump: 600 to 1500 grpm Low Speed pump: 375 to 1200 grpm
Drive Rotation	Pump can be configured to operate in CW or CCW direction

Environment

Operating Temperature	0 to +55 °C (32 to +131 °F)
Storage Temperature	−40 to +85 °C (−40 to +185 °F)
EMC	EN61000-6-2: Immunity for Industrial Environments EN61000-6-4: Emissions for Industrial Environments
Humidity	US MIL-STD 810E, Method 507.3, Procedure III
Shock	MS1-40G 11ms sawtooth
Vibration Qualification Test- Random:	0.3 G ² /Hz, 10–2000 Hz (22.1 Grms) 3 h/axis
Thermal Shock	SAE J1455, Paragraph 4.1.3.2
Ingress Protection	IP45 for Entire Unit, IP56 for User Interface per EN60529

Compliance

CE	Compliant with EMC Directive 89/336/EEC
Other	Compliant as a component with Machinery Directive 98/37/EC

Functions

Function Options	Start Fuel Limiter; Adjustable Max Fuel Stop; Jump and Rate Limiter; Position-based Gain curve; Manifold Air Pressure Biased Fuel Limiter, Analog set-point rate limit; separate Raise and Lower Rates; Start Gain
Programming Port	Programmable with Windows GUI software (9927-1366) and harness

I/O	4–20 mA analog speed setting; Analog Speed Set-point selector Raise, Lower, and Stop discrete inputs Analog Speed Set Enable discrete input 4–20 mA boost fuel limiter input; Boost Input selector Unit Healthy discrete out
Front Panel Functions	Raise and Lower speed set-point commands Stop command; Droop adjustment; Stability adjustment, Fuel-Limit adjustment
Front Panel Indications	Unit Healthy status indication, Speed Set-point mode indications (Raise/Lower or Analog)

I/O Specifications

Power Input (1 and 2)

Parameter	Value
Range	18–32 Vdc
Power Consumption	Nominal consumption is less than 500 mA. If internal failures occur, the device can draw 32 W maximum. (18 V @ 1.8 A)
Protection	Reverse-polarity protected
Isolation	None

Status (Unit Health) Output

Parameter	Value
Output Type	Low-side output driver
Max Contact Voltage (Open)	32 V
Max Current	0.5 A
Max Contact Voltage at 0.5 A (Closed)	1.5 V
Max Delay Time for Opening Contact	6.5 ms
Default at Power Up	On (conducting), if there are no faults
During Error Condition	Off
Driving Inductive Loads	Yes, internally protected low-side switch
Protection	Utilizes circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed

Boost Input

Parameter	Value
Input Type	4–20 mA
Input Scaling	4 mA is minimum boost signal 20 mA is maximum boost signal
Max Input (Full Scale)	0 mA to 25 mA
Input type	Differential
3db Circuit Bandwidth	30 Hz
Input Impedance	200 Ω
Anti-Aliasing Filter	1 anti-aliasing pole at 0.47 ms (338 Hz)
Resolution	10 bits
Accuracy	$\pm 0.8\%$ of full scale at 25 °C
Drift	80 ppm/°C
I/O Latency	6.5 ms
CMRR	60 dB
Common-Mode Range	45 Vdc

Boost Input Selector

Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull this input to ground to allow for 4–20 mA boost signal to be used.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

Analog Speed Set Point

Parameter	Value
Input Type	4–20 mA
Input Scaling	4 mA is minimum boost signal 20 mA is maximum boost signal
Max Input (Full Scale)	0 mA to 25 mA
Input type	Differential
3db Circuit Bandwidth	30 Hz
Input Impedance	200 Ω
Anti-Aliasing Filter	1 anti-aliasing pole at 0.47 ms (338 Hz)
Resolution	10 bits
Accuracy	$\pm 0.8\%$ of full scale at 25 °C
Drift	80ppm/°C
I/O Latency	6.5 ms
CMRR	60 dB
Common-Mode Range	45 Vdc

Analog Speed Set Point Enable

Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull this input to ground to allow for 4–20 mA remote speed signal to be used.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

Remote Run/Stop Input

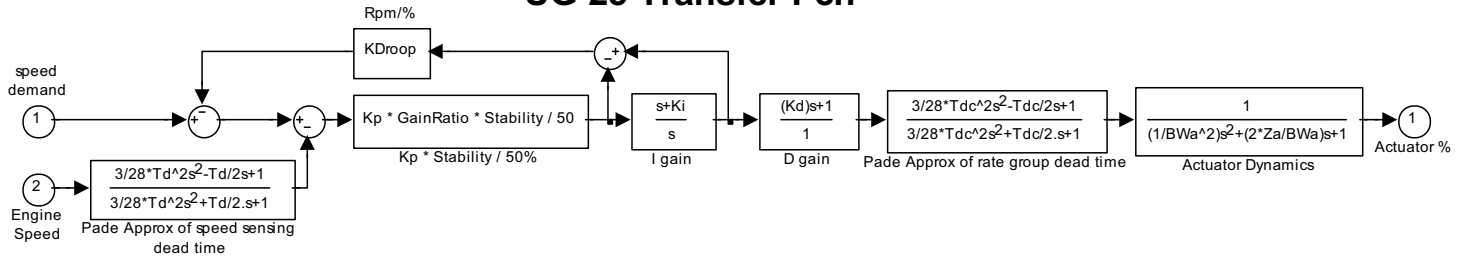
Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull this input to ground to shut down the governor.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

Remote Speed Raise/Lower Discrete Inputs

Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull these inputs to ground (individually) to remotely apply speed raise or speed lower commands.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

Transfer Function

UG 25 Transfer Fcn



T_d = Speed Sensor delay. Depends on Speed Sensor settings and speed. $T_d = 15 / \text{Rpm} * \text{Nstroke} * \text{CylindersAveraged} / \text{CylinderCount}$

$N_{\text{stroke}} = 2$ or 4 (2 stroke or 4 stroke)

$\text{CylindersAveraged} = 1$ to CylinderCount (speed input setting)

$\text{CylinderCount} =$ total number of cylinders (speed input setting)

$K_{\text{Drp}} = \text{Droop} [\% \text{ speed droop} / 100\% \text{ load}] * \text{Rated Speed} [\text{rpm}] / 100\%$

$K_p = \text{Proportional Gain} [\% / \text{rpm}]$

$\text{GainRatio} = 1$ within the GainWindow, as set in speed loop setup outside the GainWindow

$\text{Stability} = \text{Proportional Gain modifier}$. 50% = Gain of 1.

$K_i = \text{Integral Gain} [\text{repeats/sec}]$

$K_d = \text{Derivative Gain} [\text{sec}]$

$T_{dc} = \text{calc time delays, including 1.5 multiplier} = 0.011 [\text{sec}]$

$BW_a = \text{actuator Bandwidth}$ Depends on position loop gain. @ $P=44$, $BW_a=30$. @ $P=36$, $BW_a=25$. @ $P=26$, $BW_a=15$

$Z_a = \text{actuator damping ratio}$. Depends on position loop gain. @ $P=44$, $Z_a=0.8$ @ $P=36$, $Z_a=0.7$ @ $P=26$, $Z_a=0.7$

UG-25⁺ Configuration Summary

APPLICATION _____

ACTUATOR SERIAL NUMBER _____

For details on individual settings refer to Chapter 6.

Properties _____

Speed Input

Engine Type (stroke) 2 _____ 4-Stroke _____
Speed Ratio (engine to shaft) = _____
Number of Cylinders = _____
Number of Cylinders Averaged = _____
Friction / Dither Setting = _____

Start Settings

Start Fuel One _____ Two _____
Start 1 Speed Threshold = _____
Start Speed Hysteresis = _____
Start Fuel 1 = _____
Stop Speed Threshold = _____
Run Speed Threshold = _____

Start 2 Speed Threshold = _____
Actuator Ramp Rate = _____
Start Fuel 1 = _____

Start Target Speed Min _____ Rated _____
Start Target Rate = _____

Speed Set Point

Min Set Point Limit = _____
Rated Speed Set Point = _____
Max Set Point Limit = _____
Overspeed Set Point = _____
Raise Ramp Rate = _____
Lower Ramp Rate = _____
Max Analog Rate = _____

Fuel Limit

Mode Pot _____ Analog _____
Maximum Fuel Limit = _____

Boost Input % (pt 1) = _____
Boost Input % (pt 2) = _____
Boost Input % (pt 3) = _____
Boost Input % (pt 4) = _____
Boost Input % (pt 5) = _____
Limit % (pt 1) = _____
Limit % (pt 2) = _____
Limit % (pt 3) = _____
Limit % (pt 4) = _____
Limit % (pt 5) = _____

Jump Rate Limiter

Use Jump Rate Limiter? Yes _____ No _____
Maximum Jump Up % = _____
Maximum Up Rate %/sec = _____

Dynamics

Mode Single _____ Curve _____
Start Gain (%/rpm) = _____
Start Delay (sec) = _____
Integral Gain (%) = _____
Derivative Gain (%) = _____
Gain Window (rpm) = _____
Gain Ratio = _____

Proportional Gain (%/rpm) = _____

Position % (pt 1) = _____
Position % (pt 2) = _____
Position % (pt 3) = _____
Position % (pt 4) = _____
Position % (pt 5) = _____
Gain %/rpm (pt 1) = _____
Gain %/rpm (pt 2) = _____
Gain %/rpm (pt 3) = _____
Gain %/rpm (pt 4) = _____
Gain %/rpm (pt 5) = _____

Security

Read Configuration security? Yes _____ No _____
Configuration Load security? Yes _____ No _____
Speed Dynamics Edit security? Yes _____ No _____
Password = _____

DECLARATION OF CONFORMITY

Manufacturer's Name: WOODWARD GOVERNOR COMPANY (WGC)
Industrial Controls Group

Manufacturer's Address: 1000 E. Drake Rd.
Fort Collins, CO, USA, 80525

Model Name(s)/Number(s): UG 25+ Governor, 8528-001 and similar

Conformance to Directive(s): 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on
the approximation of the laws of the Member States relating
to electromagnetic compatibility and all applicable
amendments.

Applicable Standards: EN61000-6-4, (2001): EMC Part 6-4: Generic Standards -
Emissions for Industrial Environments
EN61000-6-2, (2006): EMC Part 6-2: Generic Standards -
Immunity for Industrial Environments

**We, the undersigned, hereby declare that the equipment specified above conforms to the above
Directive(s).**

MANUFACTURER

Signature

Full Name

Position

Place

Date

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please include the manual number from the front cover of this publication.



PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

Complete address / phone / fax / email information for all locations is available on our website.

INSTRUCTIONS PLATE HEAT EXCHANGERS

1000 D-GB

ISO 9001 Certified



(株) 韓國 피에치이
Korea PHE Corporation

CONTENTS

1 PRINCIPLE AND CONSTRUCTION

1.1 Principle of the plate heat exchanger	5
1.2 Construction of the plate heat exchanger	5

2 FUNCTION

2.1 Function of the plate heat exchanger	6
2.2 Assembly drawing - description	7
2.3 Diagram - description	8

3 MOUNTING INSTRUCTION

3.1 Assembling of edge-clamped frame	10
3.2 Mounting requirements	11

4 START UP - OPERATION - STOP AND TROUBLE-SHOOTING

4.1 Procedure for start-up	13
4.2 Procedure during operation	14
4.3 Procedure for stop	14
4.4 Trouble-shooting	14

5 MAINTENANCE AND CLEANING

5.1 Separation	17
5.2 Cleaning	17
5.3 Assembling	19
5.4 Replacement of plates and gaskets	20
5.5 Reconstruction of the plate heat exchanger	23

6 SPARE PARTS AND ACCESSORIES

6.1 Ordering procedure	24
6.2 Accessories	25

Enclosures at the back of the manual: Drawing

Diagram

1) PRINCIPLE AND CONSTRUCTION

1.1) PRINCIPLE OF THE PLATE HEAT EXCHANGER

A plate heat exchanger consists of an edge-clamped frame within which a number of cold-compressed plates are compressed. These are

made with special corrugations which ensures turbulent flow and high heat transfer coefficients.

1.2) CONSTRUCTION OF THE PLATE HEAT EXCHANGER

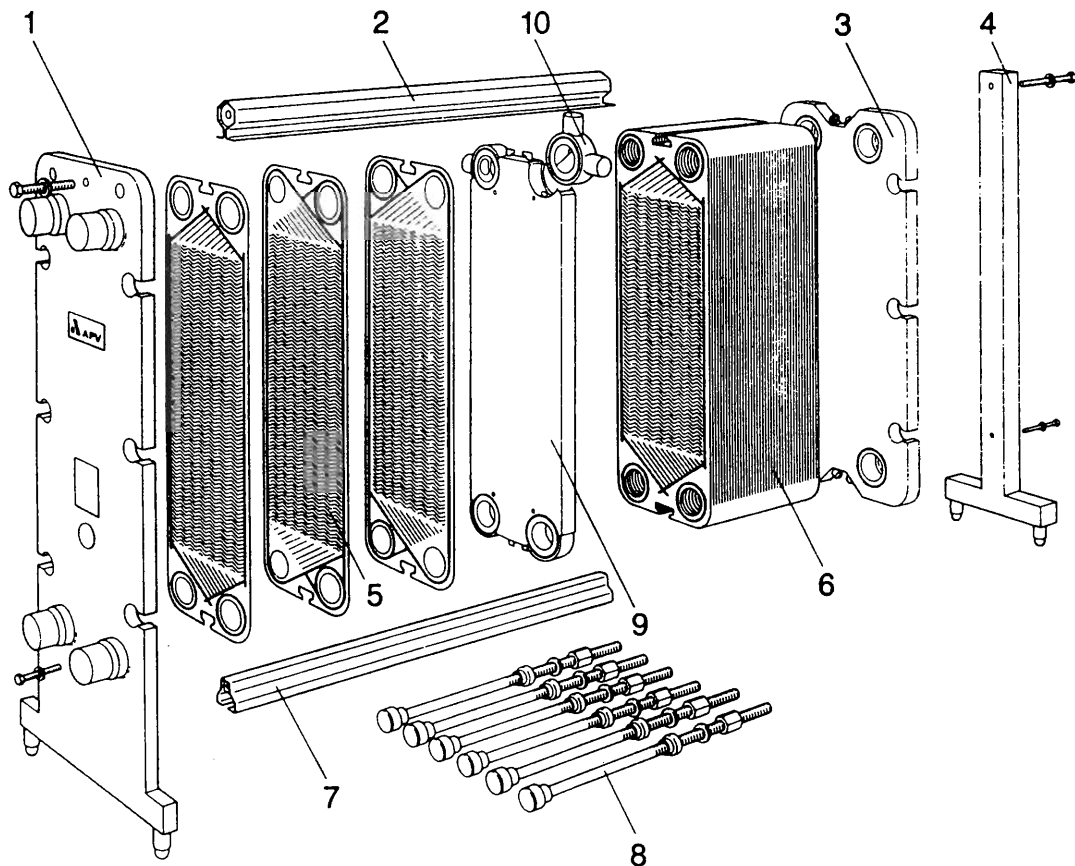


Fig. 1

1. Head
2. Top bar
3. Follower
4. End support
5. Flow plate
6. Plate pack
7. Bottom bar
8. Tie bolts
9. Connector grid
10. Connector boss

Example of plate heat exchanger coated with stainless steel.

Connector grid (9) and connector bosses (10) are only used in plate heat exchangers with two or more sections.

2) FUNCTION

2.1) FUNCTION OF THE PLATE HEAT EXCHANGER



Fig. 2

2.1.1) PLATES

After clamping of the plate pack, the plates - which are fitted with gaskets - ensure an effective seal between fluids and atmosphere (fig. 2). In addition, intermixing of the fluids is eliminated by a double gasket seal around the inlet ports (fig. 3).

Every second plate is turned through 180°. This means that the double gasket seal occurs around every second inlet to the channels between the plates.

The plate pack now forms a series of parallel flow channels in which the fluids flow in a counter current regime (fig. 4).

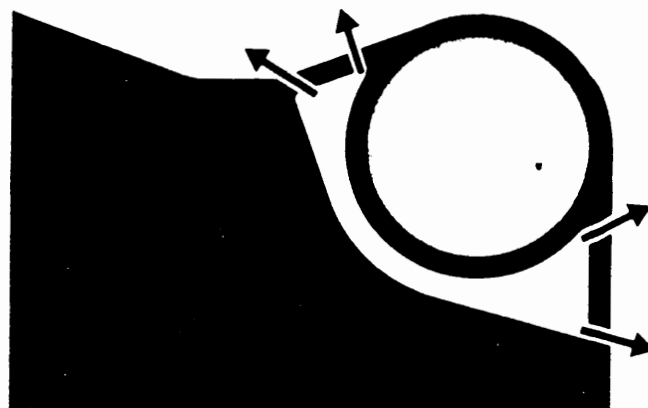


Fig. 3

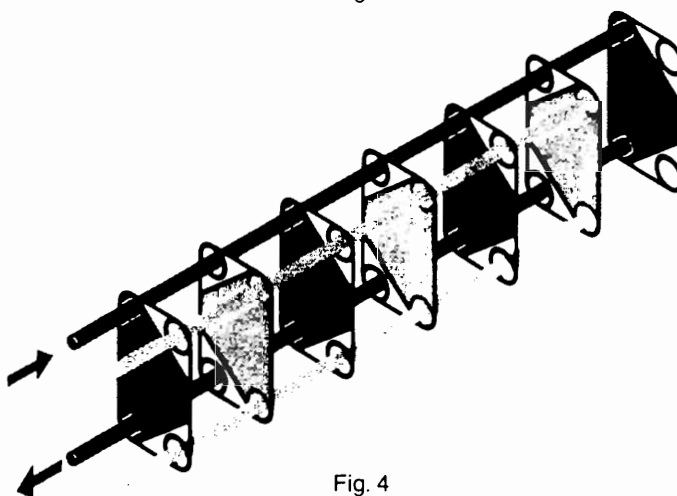


Fig. 4

2.1.2) CONNECTOR GRIDS

Connector grids must be inserted in a plate heat exchanger operating simultaneously with several media.

These connector grids divide the plate heat exchanger in separated sections. The connector grids are equipped with exchangeable connector bosses (fig. 5).

The connector bosses form the connecting link between the respective sections of the plate heat exchanger and/or connections for pipes. Two connecting branches can be provided in the same connection boss with connection to their respective section.

2.1.3) SEPARATING PLATES

Plate heat exchangers with more than one section requiring no inlet/outlet branches in the separation can be equipped with separating plates (strong sheet, 2-10 mm) or flow plates equipped with reinforced blankings.

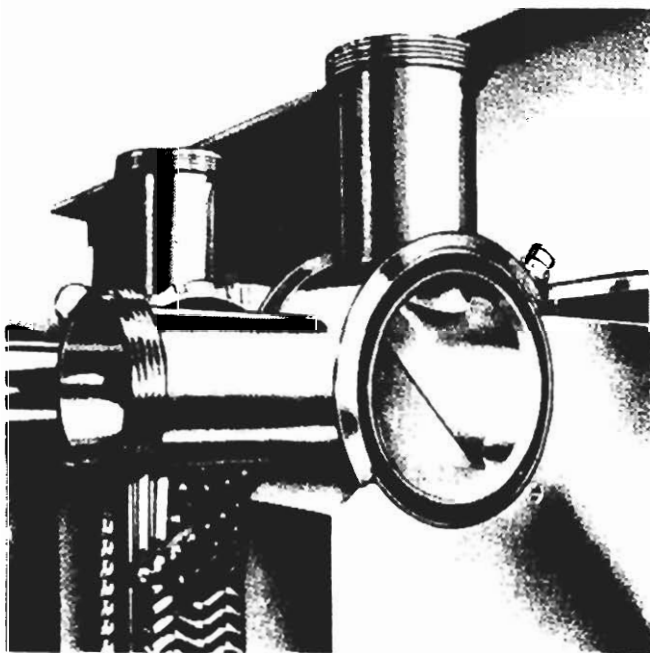


Fig. 5.

2.2) ASSEMBLY DRAWING (FIG.6)

Inside the back pocket of this manual you will find an assembly drawing. This shows all principal dimensions as well as connection specifications and identification.

HEAD = Head
G = Connector grid
FOLL. = Follower
H = Horizontal connecti
V = Vertical connection

Figures 6 a-b-c show examples of the construction of a plate heat exchanger:

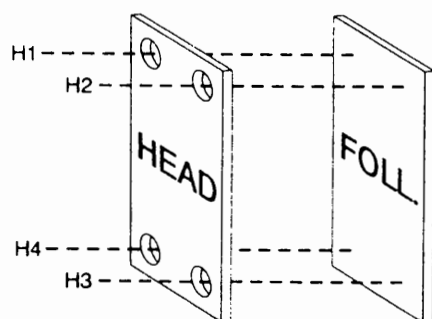


Fig. 6 a
1 section
1 pass

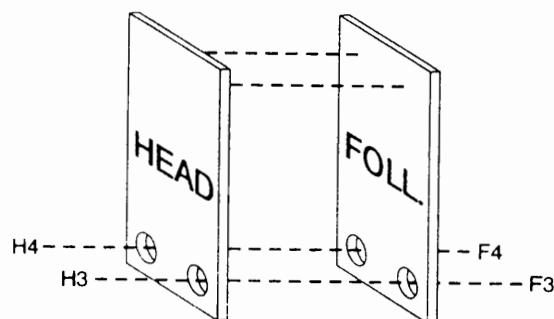


Fig. 6 b
1 section
2 passes

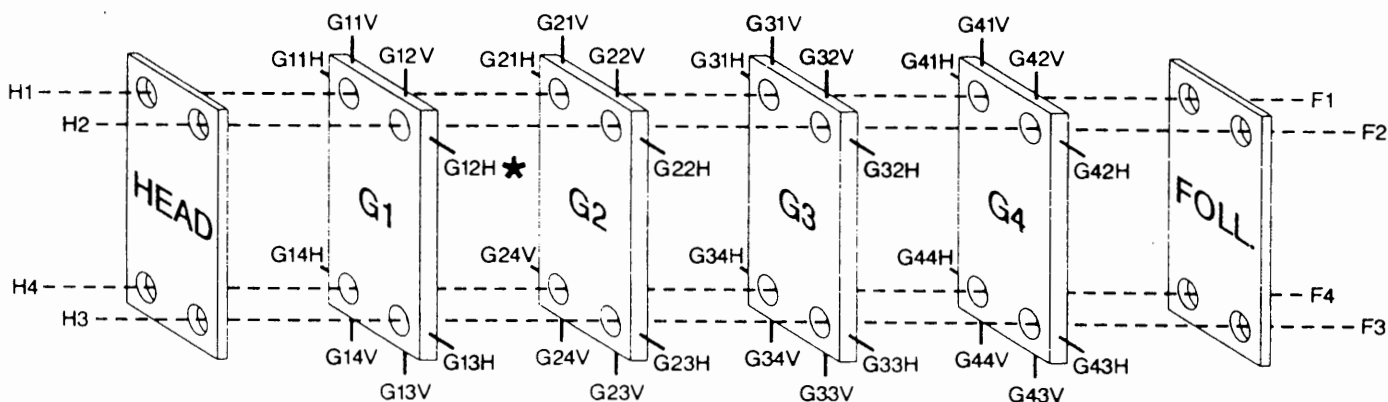


Fig. 6 c
5 sections

★ G 1 2 H

horizontally oriented
corner hole number
connector grid number from head (HEA
connector grid

2.3) DIAGRAM (FIG. 8)

2.3.1) CONFIGURATION OF THE DIAGRAM

Inside the back pocket of this manual you will also find a diagram.

The plate pack is suspended between the head and the follower. The gasket side of the plates must always face towards the head. On the right-hand side of fig. 8 can be seen a single plate viewed from the gasket side. The corner holes of the plate are designated 1-4.

Interconnecting lines have been drawn from the plate pack to the four corner holes of the plate. The flow channels for each fluid are marked with a thick or a thin line to ease identification.

2.3.2) EXAMPLE

Figs. 7, 8 and 9 show the same plate heat exchanger with a heating and cooling section separated by a connector grid G1.

The cold fluid enters the heating section via H1 in the head and flows through two parallel channels in *one pass* before entering the cooling section via hole 4 in the connector grid. From here the fluid is cooled in *two passes*, each with two parallel channels, before leaving the plate heat exchanger through F4 in the follower.

The heating medium enters through head (H3 in HEAD) and leaves again through head (H2 in HEAD).

The cooling medium enters through follower (F3 in FOLL.) and leaves through the connector boss of the connector grid (G13H).

2.3.3) REFERENCE NUMBER AND PUNCH CODE

The material quality and the four first digits of the reference number of the plate are stated in the top left-hand corner of the diagram fig. 8 (No. 1075). The four last digits of the eight-digit reference number are placed on the plate to-

gether with a punch code. The code indicates which corner holes are open to allow fluid flow.

For example: 1204* means that this plate is open in corners 1, 2, and 4, whereas corner 3 (marked with 0) is closed.

The letter H at the top is explained in section 5.4.1.

2.3.4) SERIAL NUMBERS

The numbers of the diagram - under the plates - are serial numbers, i.e. indication of the placing of the plates in the plate heat exchanger.

Serial numbers start with number 1 for the head and after that continuous numbers for each plate, connector grid, or separating plate. When extending the plate pack, the existing numbers are used, but the new plates are marked with an extra figure, e.g. 16, 17, 18, 18-1, 18-2, 18-3, 18-4, 19, 20 etc.

2.3.5) REFERENCE NUMBERS AND GASKETS

The diagram gives the reference number of gaskets for each section in the plate heat exchanger as well as quantity and reference numbers for glue and cleaning fluid for a complete replacement of all gaskets.

2.3.6) CAPACITY

The data list on the diagram gives the capacities and other criteria used for the design of the plate heat exchanger.

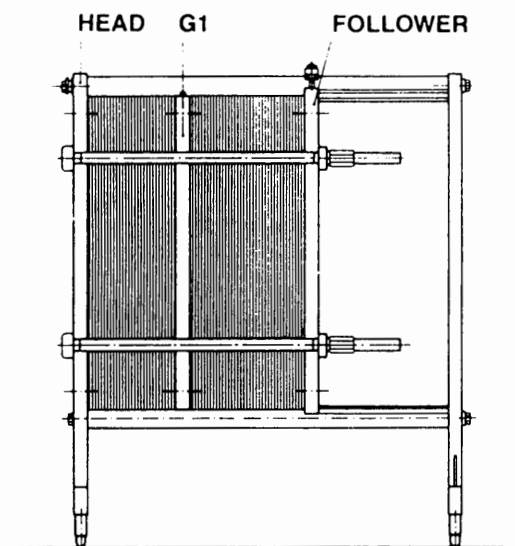


Fig. 7

5116

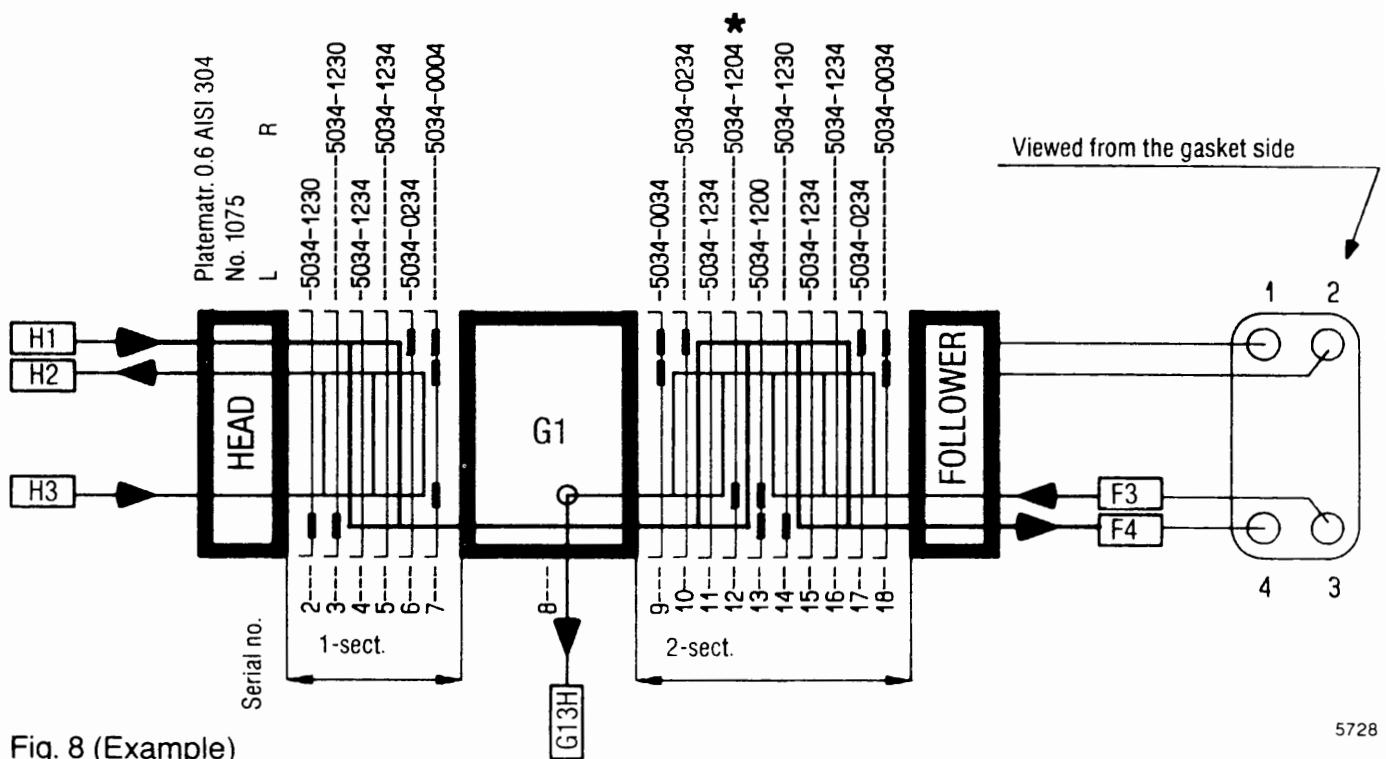


Fig. 8 (Example)

5728

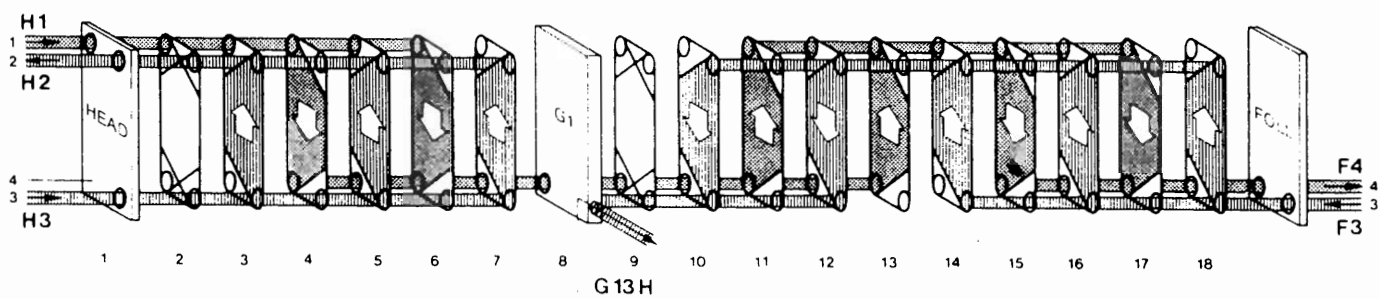


Fig. 9 (Example)

5736

3) MOUNTING INSTRUCTION



3.1) ASSEMBLING OF EDGE-CLAMPED FRAME

3.1.1) Start by erecting the head (HEAD). Secure the bottom bar (E) to the head by bolts and block it up (1), bolt the end support (2) on the bottom bar (E).

3.1.2) Place the follower (FOLL.) on two blocks (3) approx. 200 mm from the head (HEAD). Place two spacer blocks (4) at the top between the head and the follower. Retain the follower (FOLL.) with a rope (R), and remove the scotching (1).

3.1.3) Bolt the top bar (C) on the end support and the head with the fittings (5).

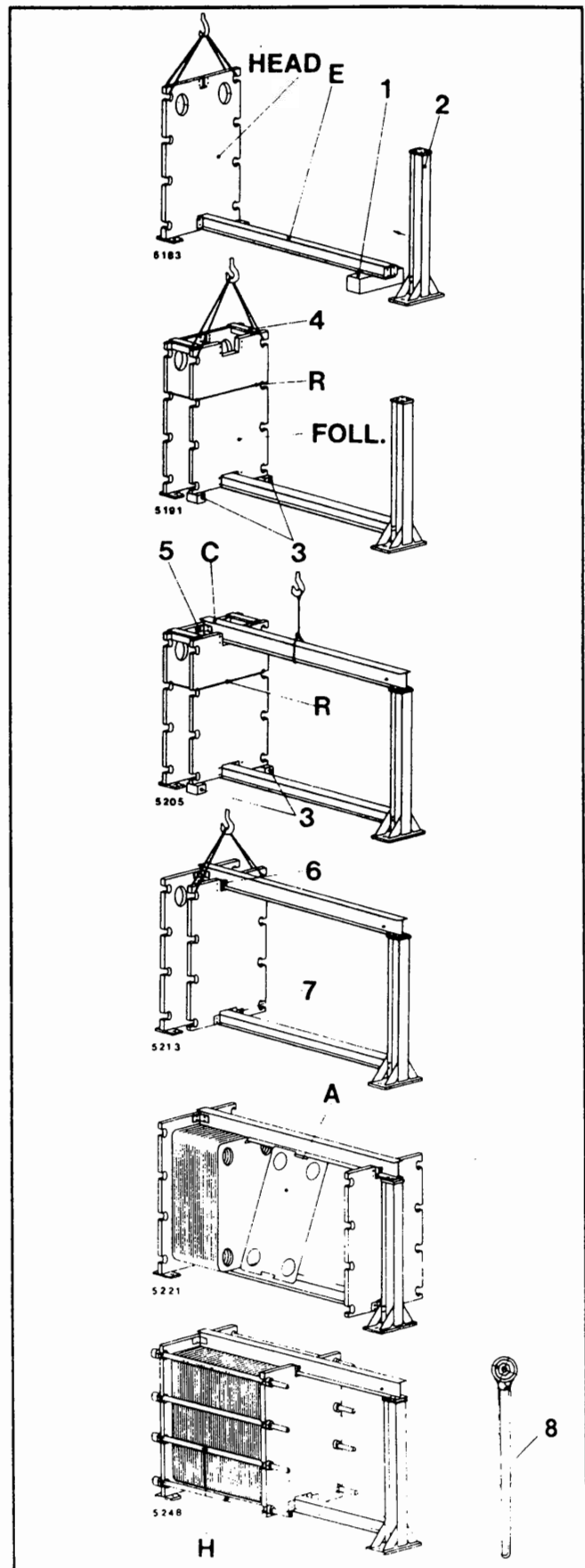
3.1.4) Fit the fittings with rollers (6) on the follower (FOLL.) so that the rollers are exactly opposite each other. Mount the bottom bar fitting (7) on the follower. Adjust the height of the follower by means of the roller fittings. Remove the blocks (3 and 4) and the rope (R).

3.1.5) Push the follower to the end support. Worm the plates (A) on the top bar one by one, turn them over the bottom bar, and push them towards the head. Insert the plates in serial-numerical order as stated in the diagram. The serial numbers must be upwards and the gasket side must face towards the head.

3.1.6) When all the plates have been correctly assembled, push the follower against the plate pack - mount the tie bolts (H) - apply a high-pressure lubricant to the threaded ends of the tie bolts. Clamping should be carried out using a ratchet spanner (8) or a similar suitable tool. Start clamping with two tie bolts diagonally opposite each other. These tie bolts can be tightened almost to the minimum plate pack dimension. Continue by clamping all the tie bolts in a diagonal manner.

Keep the head and the follower as parallel as possible during clamping and check at *all* tie bolts! (max. deviation 10 mm per m distance between the tie bolts).

The minimum clamped plate pack dimension is shown on the machine plate on the head.



3.2) MOUNTING REQUIREMENTS

The plate heat exchanger should be placed in such a way that service and inspection can easily be effected.

3.2.1) SPACE REQUIRED

On at least one side of the plate heat exchanger there must be sufficient space to unhook the plates from the top bar by a slight tilt away from the vertical. At the same time it must be possible to tighten or remove the tie bolts and inspect the plate heat exchanger (fig. 11). It must be possible to take off the spray screen or insulating jacket, if any, without having necessarily to remove the connecting pipes. This must be considered when installing the unit. All engagements are carried in a straight pipe section without thermometer, manometer or draw-off taps at a distance of 100 mm from the unit (more in case of increased insulating thickness). The distance to finish-insulated pipes should be 100 mm from the insulating jacket/spray screen. The follower must be free to move along the full length of the top bar as shown in fig. 10. See dimensions for exactly your plate heat exchanger at the back of this manual.

3.2.2) PIPE CONNECTIONS

The plate heat exchanger must be connected up according to the enclosed assembly drawing.

Threaded connections should be mounted with unions or flanges with plane tightening to

facilitate removal - alternatively with conical tightening connected to bends.

Flanged connections must be removable. Fig. 12 shows a correctly connected unit. If necessary, a suitable filter should be installed on the fluid inlet. Insulating valves are also recommended on all connections. Thermometers, pressure gauges etc. should be used as required for monitoring the plate heat exchanger performance.

3.2.3) CORRECT PIPE MOUNTING (FIG. 12)

To prevent undue strain on the plate heat exchanger frame, all pipes must be unloaded by suitable pipe holders.

The pipe joints on the follower (FOLL.) 1 and 2 must be removable in order to enable the plate heat exchanger to be opened for cleaning and inspection.

For re-tightening of the plate pack, the pipes onto the follower and any connector grids must be flexible. This can be achieved by the use of expansion joints.

During opening, it must be possible to move the follower 3, without hindrance, along the full length of the top bar.

For CIP (cleaning in place), without opening, piping material and layout must be chosen accordingly.

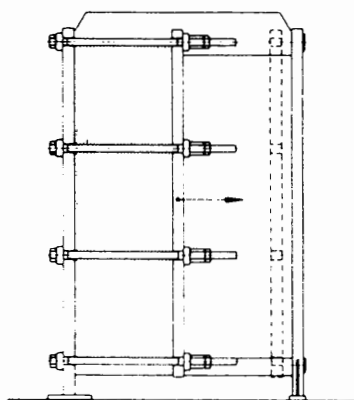


Fig. 10

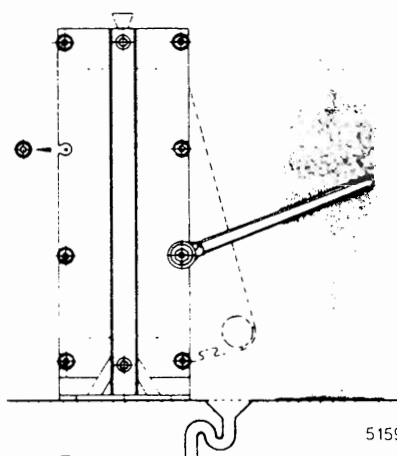


Fig. 11

5159

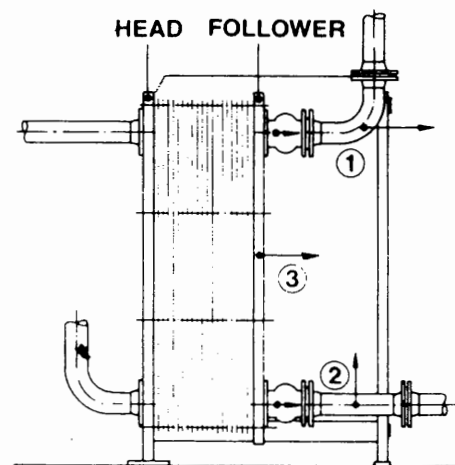


Fig. 12

5744

3.2.4) PRESSURE PULSATIONS/ VIBRATIONS

Piston pumps, gear pumps, dosing devices etc. must not be able to transfer pressure pulsations/vibrations to the plate heat exchanger as this may cause fatigue fracture in the plates.

3.2.5) EXCESS PRESSURE PROTECTOR

Excess pressure protector must *always* be mounted (fig. 13), if the plant is likely to develop a higher pressure than that stated on the machine plate. This condition may arise during pump start up, expansion or valve change-over etc.

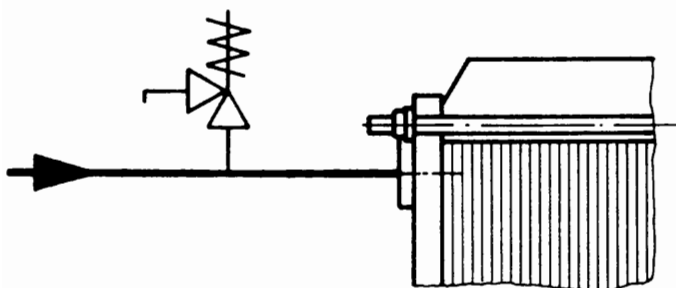


Fig. 13

5442

3.2.6) LIQUID HAMMERING

The plate heat exchanger is sensitive to liquid hammering. This can occur during regulation, change-over, pump start-up etc., see section 4.4.1. In order to avoid this situation, the use of throttling of air-operated valves, damping relays in electrical control gear, automatic pump start with closed valves etc. is recommended.

3.2.7) SHIELDING

The plate pack must be shielded, when:

- possible splashes may cause damage
- corrosive media are being used
- the working temperature may cause scalding
- required by the local authorities

Spray screens for all plate heat exchanger types can be supplied.

When thermal shielding is desirable or required, an insulating jacket can be supplied. This jacket fits the heat exchanger exactly and can be taken off without removing the connecting pipes.

3.2.8) DRAIN

Ideally a drain should be located close to the plate heat exchanger. If the drain leads to public sewage system, the possible risk of pollution should be considered. If either fluid cannot run directly to drain, suitable spill trays should be placed beneath the unit. If necessary, these should be fitted with a level alarm.

4) START-UP

4.1) PROCEDURE FOR START-UP

Before the initial start-up, check that the clamped plate pack dimension is as specified on the machine plate on the plate heat exchanger.

4.1.1) START-UP

Sudden surges and drops in pressure and temperature must be avoided, as these may damage the plates and gaskets thereby causing leakage. Pumps should be started against closed valves which can then be gradually opened until the desired flow rate is achieved.

NOTE!!!

The initial start-up of plate heat exchangers with new EPDM gaskets must be effected by increasing the temperature slowly, max. 25°C (77°F) per hour.

By restart-up and stop, the following must be observed:

Pressure surge/drop must not exceed ± 10 bar per minute.

Temperature increase/drop must not exceed $\pm 10^\circ\text{C}$ per minute.

If the above precautions are not observed, the guarantee will no longer apply.

In a plate heat exchanger using steam as the heating media, the cold fluid should be introduced to the plate heat exchanger before the steam is turned on. The potential damage possible due to the incorrect start-up increases proportionally with increased liquid flows and the length of connecting pipework!

For start-up of plate heat exchangers with grafoseal gaskets, see section 5.1.3.

4.1.2) LEAKAGE DURING START-UP

During the initial start-up, minor leaks may occur until the plates and gaskets have reached their design working temperature and all sections are correctly pressurised.

4.1.3) VENTING

When correct working temperature and working pressure have been reached, the system must be vented.

The air in the plate heat exchanger is driven out by the liquid flow, provided that the capacity is as stated in the diagram.

Air in a plate heat exchanger reduces the heat transmission and increases the pressure drop, thus increasing the risk of corrosion!

4.1.4) PERMISSIBLE PRESSURE

Working, and testing pressures are given on the machine plate.

WORKING PRESSURE = the highest pressure to which the plate heat exchanger may be subjected during operation!

TESTING PRESSURE = the pressure at which the plate heat exchanger may be tested!

Pressure testing is made as a differential pressure i.e. warm and cold side separately.

For plate heat exchangers with several sections, the stated working, testing, and differential pressures only apply if all sections are pressurised.

If each section operates at different pressures, or one of the sections is not under pressure, leaks may occur in the lower pressure section.

The maximum permissible difference in pressure between two sections separated by a connector grid or a separating plate is in general 6 kp/cm². If the two sections are not equal in size, the permissible difference is reduced. The maximum difference in pressure depends on the number of plates in the other section/s.

4.2) PROCEDURE DURING OPERATION

During operation, temperatures and pressure drops must be regularly checked. Increased pressure drop and/or falling temperatures indicate that there are coatings on the plates. The plate heat exchanger now needs cleaning.

During operation, the same precautions against rises of pressure must be observed as during start-up!

4.2.1) LEAKAGE DURING OPERATION

See section 4.4) "TROUBLE-SHOOTING".

4.3) PROCEDURE FOR STOP

In plate heat exchangers for pasteurizing, the steam is shut off, the hot-water pump is stopped, and the cooling fluids are shut off. Finally, the product pump is stopped.

If the plate heat exchanger is to be opened, it must be cooled below 40°C by letting the product pump recirculate and lowering the temperature of the circulating water by max. 10°C per minute. This is done by opening for the cooling water or adding cold water to the circuit. Plate heat exchangers with 1 section are closed down slowly so that the temperature decreases by max. 10°C per minute.

If there is no other possibility of cooling, the plate heat exchanger can be cooled with corporation water below 40°C.

Normally, the plate heat exchanger can be unpressurised by shutting off the fluid inlets and outlets. The temperature will gradually decrease to the ambient temperature.

For long working breaks, see procedure in section 5.2.3.

4.4) TROUBLE-SHOOTING

In case of damage to plates or gaskets, it will often be necessary to replace them.

First examine very carefully the external conditions around the plate heat exchanger in order to localize the cause of the damage!

In case of fatigue fracture, this will normally necessitate a replacement of all plates and gaskets - as there may be a risk of fatigue fracture in all the material.

In case of corrosion, all plates must be examined carefully!

4.4.1) VISIBLE LEAKAGE

Type of irregularity:	Possible cause:	Remedy of irregularity:
Leakage.	Too high pressure.	Reduce the pressure to the correct working pressure, which can be found on the machine plate.
Leakage. (Phase 1).	Insufficient tightening.	Tighten up the plate heat exchanger (section 5.1) - however, not under the minimum dimension and <i>never</i> , when the plate heat exchanger is under pressure or over 40°C. If the plate heat exchanger is still leaky, procede with phase 2.
Leakage. (Phase 2).	Fouled or deformed plates. Inelastic or deformed gaskets.	Separate the plate heat exchanger (section 5.1) and check if the plates are deformed or fouled. Check that the gaskets are elastic and non-deformed, and that the faces of the joints are clean. Replace deformed plates and gaskets, if any, see ordering procedure (section 6.1). Before assembling, clean very carefully all plates and gaskets (section 5.2). Assemble the plate heat exchanger (section 5.3) and start it up again (section 4.1). Note!!! Even tiny impurities such as sand grains may cause leakage.
Leakage. (Even after tightening of the plate heat exchanger to minimum dimension).	Gaskets.	Separate the plate heat exchanger (section 5.1). Clean the plates very carefully (section 5.2). Replace the gaskets. Assemble the plate heat exchanger (section 5.3) and start it up again (section 4.1).
Leakage. (Through the drain holes of the gaskets).	Defective gasket or badly corroded plate.	Separate the plate heat exchanger (section 5.1). Replace defective plates and gaskets, if any. Assemble the plate heat exchanger (section 5.3) and start it up again (section 4.1).

4.4.2) NON-VISIBLE LEAKAGE

Type of irregularity:	Possible cause:	Remedy of irregularity:
Reduced heat transmission and/or increasing pressure drop.	Fouled plates or choked plate channels.	Separate the plate heat exchanger (section 5.1) and check if the plates are fouled. Clean the plates very carefully (section 5.2). Assemble the plate heat exchanger (section 5.3) and start it up again (section 4.1).
Leakage. (The fluids get mixed). (Phase 1).	Holes in plates. Corrosion or fatigue fracture.	A suspected leakage can be localized in the following way: Remove one of the lower pipe connections. Then put the opposite side under pressure. If the medium continues to run out of the lower pipe connections - after the pressure has stabilized - one or several plates are leaking. Close down the plate heat exchanger (section 4.3). Separate the plate heat exchanger (section 5.1) and check the plates very carefully. Check suspected plates with a dye penetrant. Check defective plates and gaskets, see ordering procedure (section 6.1). Before assembling, clean all plates and gaskets (section 5.2). Assemble the plate heat exchanger (section 5.3) and check to find more defective plates, if any, by putting one side under pressure. Start up again (section 4.1).
Leakage. (The fluids get mixed). (Phase 2).	Holes in plates. Corrosion or fatigue fracture.	Close down the plate heat exchanger (section 4.3). Separate the plate heat exchanger (section 5.1). Put all plates to dry. Suspend the plates in the plate heat exchanger again and tighten it (section 5.3). Circulate medium at full capacity on one plate side (every second plate channel). Keep the other plate channels unpressurised and free from liquid! Stop the circulation after some minutes of operation and open the plate heat exchanger again. Take care to avoid water spraying onto the dry plate side! By a careful study of the plates it will be possible to find moist areas, if any, on the otherwise dry plate sides. Check these areas with a dye penetrant! Replace defective plates and gaskets, see ordering procedure (section 6.1). Before assembling, clean all plates and gaskets (section 5.2). Assemble the plate heat exchanger (section 5.3) and check to find more defective plates, if any, by putting one side under pressure. Start up again (section 4.1). If the unit is still leaking, check all plates with a dye penetrant!

5) MAINTENANCE AND CLEANING

5.1) SEPARATION

5.1.1) COOLING AND PRESSURE RELIEF

Before opening the plate heat exchanger, it must be cooled below 40°C (104°F), and it must not be pressurised!

Cooling must *not* exceed 10°C per minute.

The pressure drop must not exceed 10 bar per minute.

If these standards are disregarded, the guarantee will no longer apply!

5.1.2) SEPARATION OF EDGE-CLAMPED FRAME

On completion of the procedure in section 5.1.1, separate the frame by keeping two, perhaps four diagonally placed tie bolts clamped. Dismount the rest of the tie bolts.

NOTE: Take care that the follower does not keel over!

Loosen the last tie bolts uniformly (max. 10 mm per m distance in difference), then push the follower towards the end support (fig. 14).

NOTE: When using plate heat exchangers on board ships, the follower must be secured in order to avoid danger during the movements of the ship.

5.1.3) PLATE HEAT EXCHANGERS WITH GRAFOSEAL GASKETS

When plate heat exchangers fitted with grafoseal gaskets are separated, these gaskets should normally be replaced by new ones.

However, if the plate heat exchanger is opened, cleaned and tightened with care so that the plate sequence is unchanged and no graphite material is removed from the plate behind, the gasket can be used again. The maximum pressure will, however, be reduced somewhat.

In case of replacement of a plate, the gasket in the plate behind this plate must be replaced as well.

Grafoseal gaskets should always be handled with great care to avoid damage of the gasket surface.

NOTE: Never bend a grafoseal gasket!

5.2) CLEANING

The capacities and resistance to corrosion of plate heat exchangers depend on the plate pack being kept clean.

Foulings on the plates can be removed manually or by CIP (cleaning in place).

5.2.1) MANUAL CLEANING

Clean the plates with a soft brush and a suitable detergent (section 5.2.4).

In case of thick layers of scale or organic materials, the plates must be put in a bath of detergent (section 5.2.4).

NOTE: Never use steel brush, metal scraper or the like.

A high-pressure cleaner can be used with care - however, never with sand or other abrasives added.

5.2.2) CIP-CLEANING

A circulation system, in which a suitable detergent can be circulated is established. If the product to be flushed out has a high viscosity, the circulating quantity must be big enough to reach a sufficient speed for flushing out the product.

If the product pump is volumetric, it may be necessary to insert a pump for the detergent parallel to the former. It is assumed that the foulings on the plates are soluble in a detergent which does not attack plates and gaskets.

Example of CIP-cleaning:

- Drain off product residues and cooling and heating media.
- Rinse with cold or lukewarm water.
- Circulate with warm cleaning fluid solution.
- Rinse with warm water.
- Rinse with warm water with softener added to it.
- Rinse with cold or lukewarm water.

Cleaning can also be effected without circulation by pouring a cleaning fluid solution into the system.

After some time of standing, wash out the detergent with clean water.

5.2.3) CONTROL OF CLEANING

The plate heat exchanger must be opened for inspection at regular intervals. This is necessary especially during the running-in period, until experience has been gained on the effectiveness of the cleaning process.

With these inspections, it will gradually be possible to determine circulation times, temperatures, and chemical concentrations with great certainty!

Insufficient cleaning is most often due to:

- too small circulation quantity.
- too short cleaning period.
- too small chemical consumption in relation to the foulings on the plates.
- too long periods of operation.

If the plate heat exchanger is out of operation for a long time, it is advisable to empty it, separate the plates, and *clean* the unit.

Clamp the plate heat exchanger lightly together, and leave it covered in order to protect the gaskets against dirt and the effect of light!

5.2.4) DETERGENTS

The definition of a suitable detergent is brief and to the point. Coatings on the plates must be removed without damaging plates and gaskets. It is important not to decompose the passivating (protective) film of stainless steel - the film contributes to preserving the resistance of the steel to corrosion.

Do not use chlorine-containing agents such as hydrochloric acid (HCl)!!!

EXAMPLES:

- OIL AND FATS are removed with a water emulsifying oil solvent, e.g. BP-SYSTEM CLEANER.
- ORGANIC AND GREASY COATINGS are removed with SODIUM HYDROXIDE (NaOH) - max. concentration 1.5% - max. temperature 85°C (185°F). 1.5% concentration corresponds to 3.75 l 30% NaOH per 100 l water.

- FURRINGS AND SCALE DEPOSITS are removed with NITRIC ACID (HNO₃) - max. concentration 1.5% - max. temperature 65°C (149°F).

1.5% concentration corresponds to 1.75 l 62% HNO₃ per 100 l water.

Nitric acid has an important constructive effect on the passivating film of stainless steel.

5.2.5) CONTROL OF CLEANING FLUID CONCENTRATION

SODIUM HYDROXIDE (NaOH) solution is titrated with 0.1 n HYDROCHLORIC ACID (HCl) with methyl orange or methyl red as indicator. NITRIC ACID (HNO₃) solution is titrated with 0.1 n SODIUM HYDROXIDE (NaOH) with phenolphthalein as indicator.

The concentration of the cleaning fluid in % can be calculated from the titration result according to the following formula:

$$\text{CONCENTRATION} = \frac{b \times n \times m}{a \times 10} \%$$

a = ml cleaning fluid taken out for titration

b = ml titration fluid used for change of colour

n = normality of titration fluid

m = molecular weight of cleaning fluid (NaOH) molecular weight 40 - HNO₃ molecular weight 63).

In order to use the correct quantity of chemicals for CIP cleaning, the cleaning fluid should be checked immediately before flushing. If the concentration is too low, <0.5%, the plate heat exchanger is probably not clean. If the concentration is too high, >1%, the chemical consumption can be reduced.

5.3) ASSEMBLING

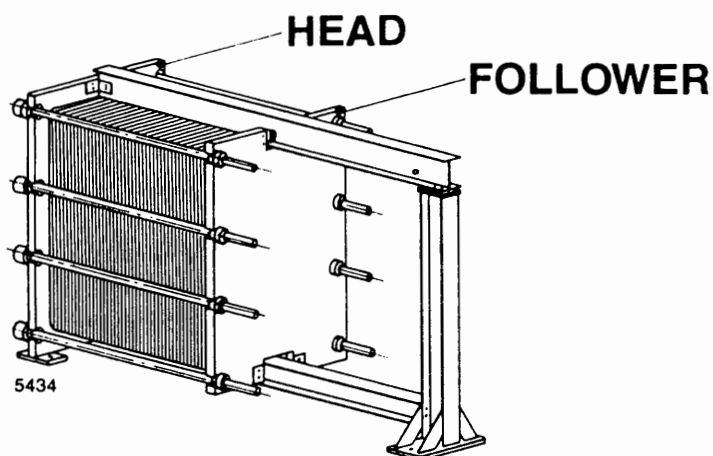
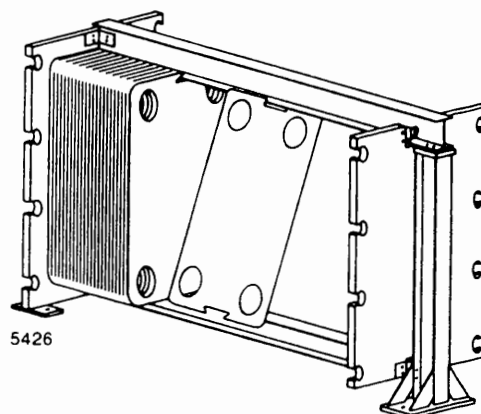


Fig. 14



5.3.1) ASSEMBLING

If the plates have been dismantled, they must be correctly inserted according to serial numbers!

The head has No. 1, and the serial numbers of the following plates and the connector grids, if any, are 2, 3, 4, 5 etc.

The serial number is marked in the top right-hand corner of the plates - do not forget that the gasket side must face towards the head.

5.3.2) CLAMPING

The maximum and minimum dimension for clamping is stated on the machine plate, which is placed on the head.

The plate heat exchanger must be clamped to dimension between max. and min. dimension.

The final clamping to minimum dimension is recommended after approx. one month's operation - alternatively, immediately after installing new plate heat exchangers/new gaskets.

New gaskets in EPDM quality are clamped step-wise the first time:

1. Minimum dimension +15%
2 hours' interval or more.
2. Minimum dimension +7.5%
12 hours' interval or more.
3. A dimension between max. and min. dimension as stated on the machine plate, alternatively min. dimension.

The head and the follower must be exactly parallel. Therefore, clamping must be measured at the top, in the middle, and the bottom on both sides.



Fig. 15

Plate heat exchangers with Grafoseal gaskets, see section 5.1.3.

5.4) REPLACEMENT OF PLATES AND GASKETS

5.4.1) MARKING

The plates are marked with material codes and reference number plus codes for non-glue gasket, if any, and also have the letter H (fig. 16). Looking towards the gasket side, the plate is designated a right plate when the H is upwards and a left plate when the H is downward.

Left plates have inlet and outlet via corner holes 1 and 4, respectively.

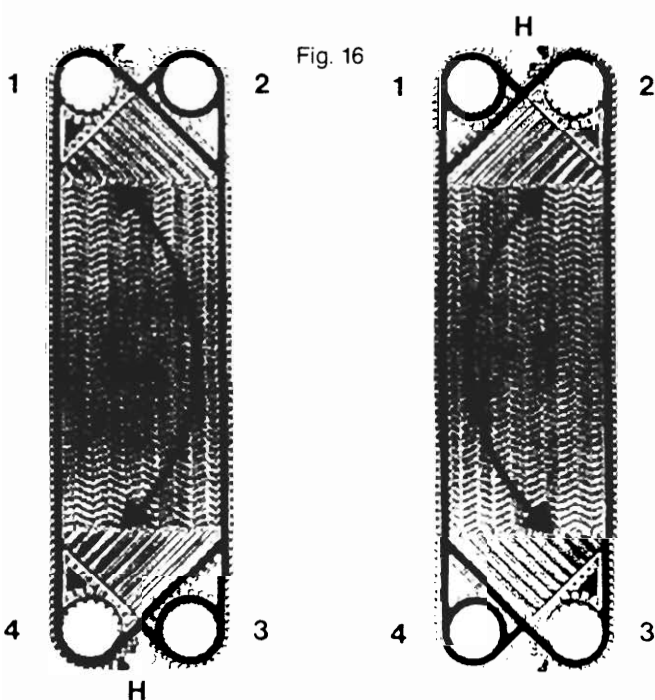
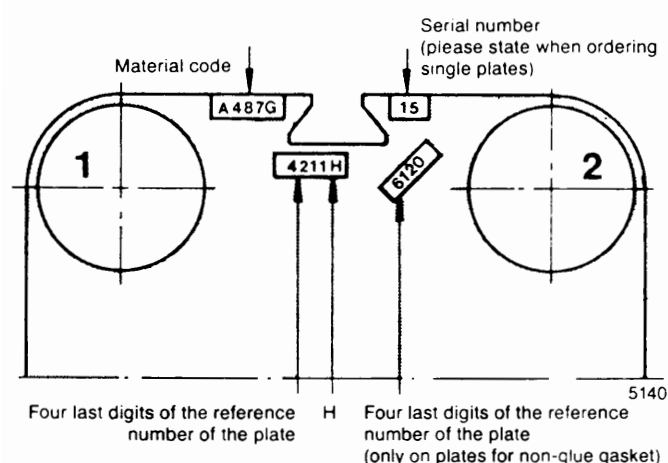


Fig. 17

Right plates have inlet and outlet via corner holes 2 and 3, respectively (fig. 17).

H = right plate

5.4.2) REPLACEMENT OF PLATES

Before inserting a spare plate in the plate pack, it must be checked that the spare plate is identical with the defective plate - the same corner holes open, and the mark H must face right.

If the width of new plates is not the same as that of the plates they are to replace - or of those of the plate pack being extended, the widest plates are to be fitted at the back of the plate pack, if possible; adjacent to the grid, separator plate or follower. New plates always differ from old plates. Therefore, new plates are to be grouped together, if possible.

As an example, the current, nominal width of »K«-range plates is 483 mm. Previously it was smaller.

A defective 4-hole plate can be removed from the plate pack without inserting a spare plate, if the adjoining 4-hole plate is also removed. The new number of plates will then be = S-2. This changes the clamping measure of the plate pack to M1 which will be:

$$M1 = \frac{M(S-2)}{S}$$

M = The original clamping dimension stated on the machine plate.

S = The original number of plates in the plate pack.

The transmission area of the plate heat exchanger is reduced in relation to the original number of plates. At the same time, the pressure drop will increase. As to corrosion and fatigue fracture of plates, see section 4.4 trouble shooting. Ordering procedure for plates can be found in section 6.1.

5.4.3) REPLACEMENT OF GLUED GASKETS

On the diagram inside the back pocket of this manual you will find an order list for gaskets and details of glue type and quantity. Also given is information concerning the degreasing solvent for the new gaskets.

The first plate after the head and the connector grid must have a gasket in all grooves. These gaskets are, in fact, two "normal" gaskets cut in half and glued in place around all grooves. You should carefully note how the old gaskets are assembled before removing them!

5.4.4) REMOVAL OF OLD GASKETS

- PLIOBOND glued gaskets can be loosened by heating in water at 100°C (212°F).

The plates are cleaned, and coatings, if any, are removed.

See section 5.2.4.

5.4.5) CLEANING

New gaskets and the gasket grooves of the plates are cleaned with a cloth moistened with degreasing agent. The gluing surfaces must be absolutely clean - without finger prints etc.

As degreasing agent use what is stated on the enclosed diagram.

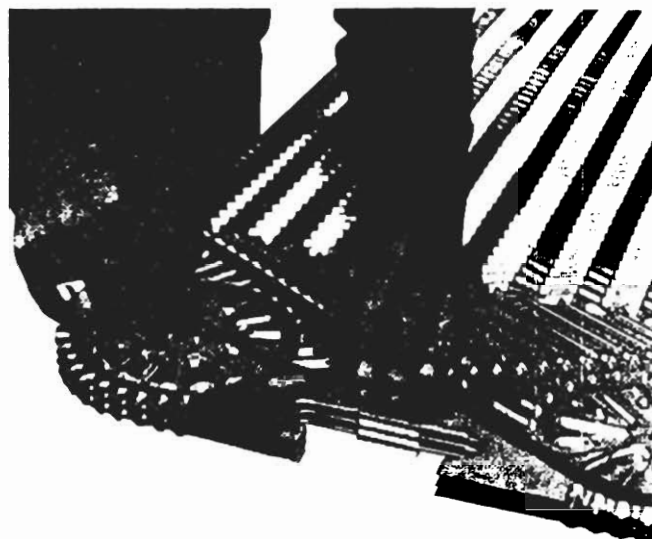
Alternatively, use: TRICHLOROETHYLENE, CHLOROTHENE VG, ACETONE, METHYL ETHYL KETONE or ETHYL ACETATE.

It is important that all the degreasing agent has evaporated, before the glue is applied. This will normally take approx. 15 min. at 20°C (68°F).

It is advisable to clean the gluing surfaces of the gaskets with fine-grain sandpaper instead of degreasing agent.

5.4.6) GLUING

- PLIOBOND 25, which is a nitrile rubber glue on solvent basis (25% solids), is applied with a brush in a thin layer on the backs of the gaskets. The gaskets are put to dry in a clean and dustless place! The gasket grooves of the plates are now coated with a thin layer of glue,



and the gaskets are cemented into the grooves. The insertion of gaskets starts at both ends of the plate - and continues with the straight sections along the edges.

The gluing process is most easily effected by laying the gaskets and the plates on a table - as the gaskets are cemented into the grooves of the plates, the plates should be stacked.

The plates with the gaskets are now suspended in the frame which is clamped lightly, for rubber gaskets e.g. to the minimum dimension indicated on the machine plate plus 0.2 mm per plate.

The plate heat exchanger is heated to 90-100°C (194-212°F) by means of water or steam - the temperature must be kept for 1½-2 hours!

The liquid pressure must be kept as low as possible. On plate heat exchangers for food, pipe branches which are not connected to water/steam must be kept free, in order to permit glue vapours to escape!

If there is no possibility of heating the plate heat exchanger, it must stand at a place as warm as possible with dismantled connections.

The drying time will at 20°C (68°F) be approx. 48 hours. At e.g. 40°C (104°F), the drying time is reduced to approx. 24 hours.

When the glue vapours have vaporized, the plate heat exchanger can be clamped again as stated in section 5.3.

5.4.7) NON-GLUE PARACLIP GASKETS

PARACLIP is a non-glue gasket designed as a conventional gasket. It is designed with a special clip-on feature which locks it into recesses in the gasket groove on the plate.

When replacing PARACLIP gaskets, the old gasket is removed completely. Before fitting the new PARACLIP gasket, check that the plate gasket groove is clean and free from residual rubber, particularly in the clip-on pockets. New gaskets can be fitted without using tools.

The first plate after the head and the connector grids, which have no physical contact with the

product, are equipped with a glued gasket as described, see section 5.4.6.

However, it will seldom be necessary to change these as their only purpose is to fill out the gasket groove thereby supporting the rest of the plate pack.

The PARACLIP gasket is available for food as well as non-food purposes. When assembling, the EPDM quality gasket should be wiped with a cloth wetted with silicone oil to facilitate the separation from the connecting plate when disassembling the plate pack.

On the enclosed diagram you will find an order list for gaskets.



Fig. A



Fig. B

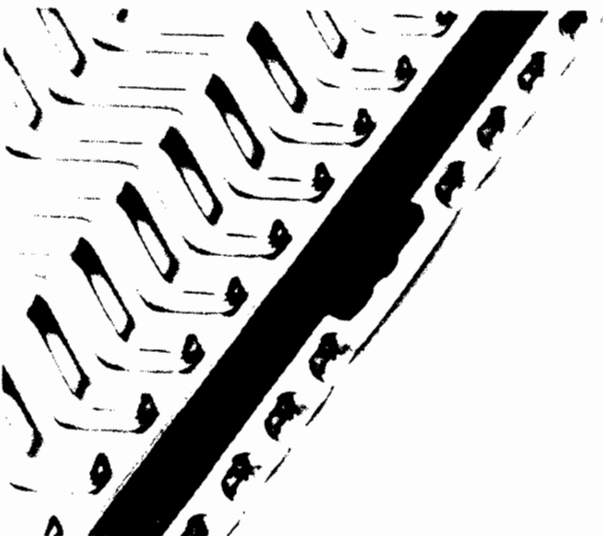


Fig. C

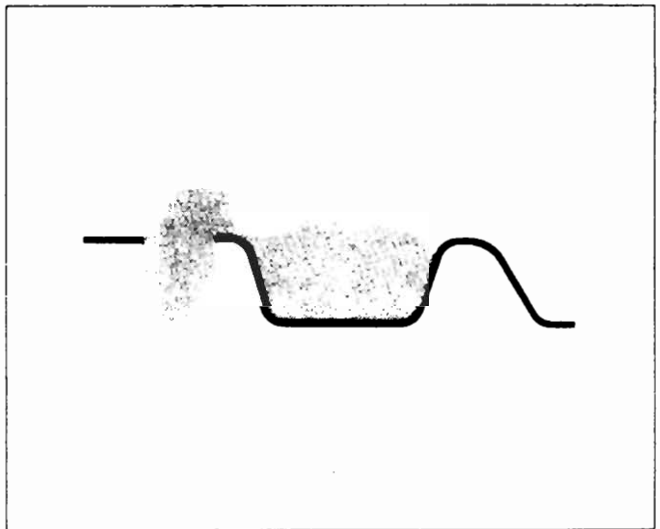
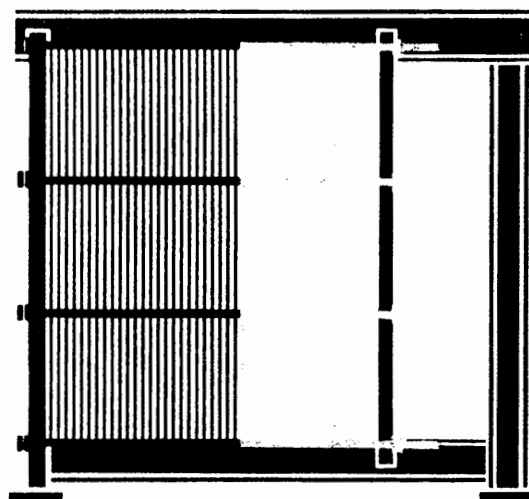
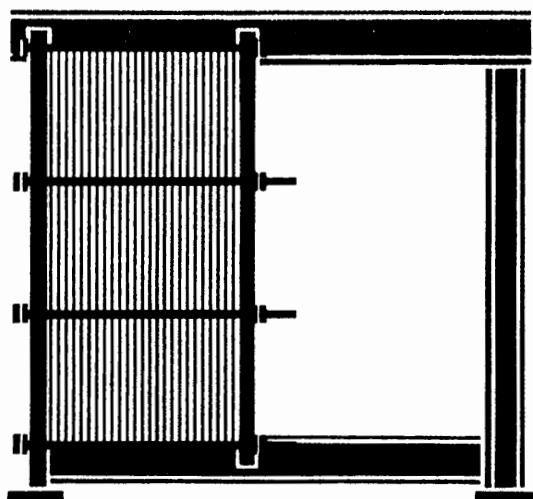


Fig. D

5.5) RECONSTRUCTION

The modular construction of the plate heat exchanger ensures an easy extension or reduction in the capacity.

In case of reconstruction, all the customer has to do is to state the type designation, serial number and the wanted change. **APV Heat Exchanger** has all relevant data in file and can immediately submit a suggestion and a quotation for the reconstruction.



6) SPARE PARTS AND ACCESSORIES

6.1) ORDERING PROCEDURE

When ordering plates, please state the serial numbers of the plates and the type and serial number of the plate heat exchanger.

The serial numbers of the plates can be found in the top right-hand corner of the plates (fig. 16, page 20) - the type and serial number of the plate heat exchanger can be taken from the machine plate!

ORDER EXAMPLE:

4 plates with glued-on gaskets, serial numbers 11, 12, 13, and 14 - plate heat exchanger type H 17 - serial number 19156.

ORDER EXAMPLE OF A COMPLETE SET OF PLATES:

1 complete set of plates with glued-on gaskets - plate heat exchanger type M 107 - serial number 28452.

ORDER EXAMPLE OF A COMPLETE SET OF PLATES FOR ONE SECTION:

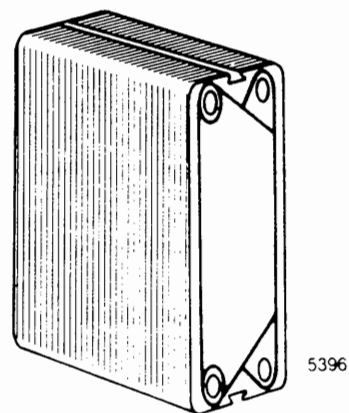
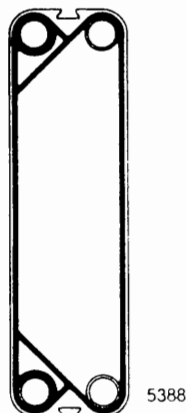
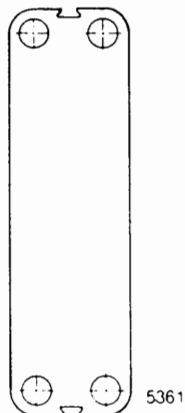
1 complete set of plates with glued-on gaskets for the heat recovery section - plate heat exchanger type K 55 - serial number 32254.

The plates are marked with a material code (fig. 16, page 20) symbolizing the steel quality. The four digits after the letter are APV's internal press operation number (three-digit number and a letter).

When knowing the material code, **APV Heat Exchanger** can procure a certificate of the plate.

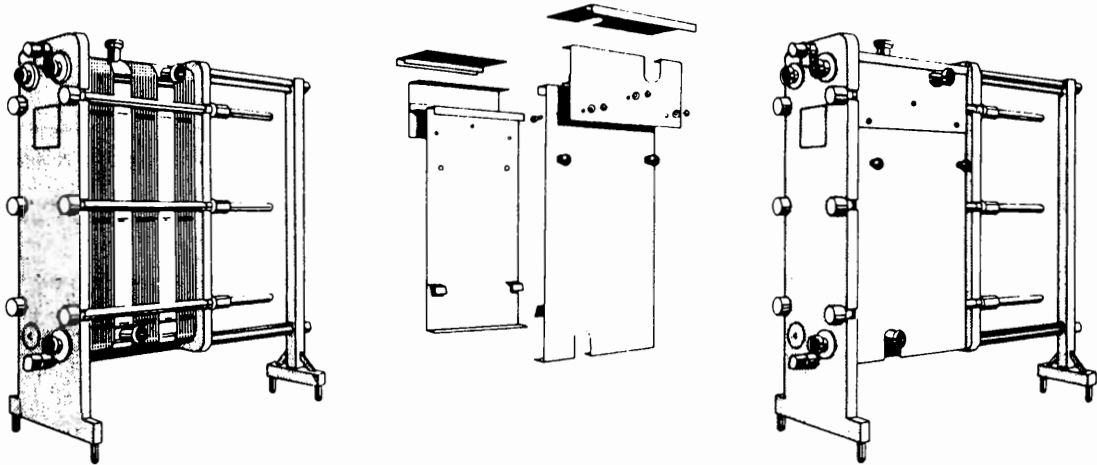
MATERIAL CODE:

CODE	DESIGNATION	PREVIOUSLY USED CODE
A	Stainl. steel AISI 304	C E G J M R
B	Stainl. steel AISI 316	D F H K N P
S	Stainl. steel W 1.4449 (Avesta 832 SL)	
T	Titanium ASTM B 265 grade 1	
X	Stainl. steel W 1.4539 (Avesta 254 SLX)	
Y	Stainless steel (Avesta 254 SMO)	
Z	HASTELLOY C 276	
	Monel	U
	Cu-Al	M

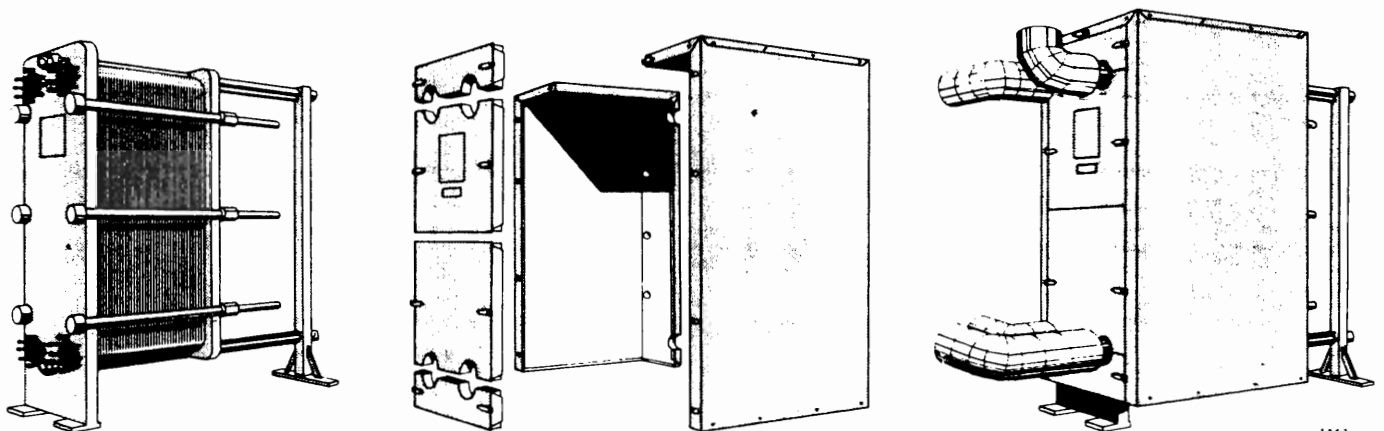


6.2) ACCESSORIES

6.2.1) SPRAY SCREENS

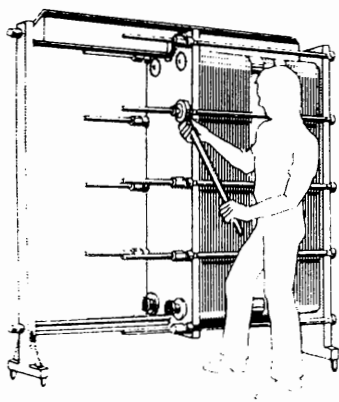


6.2.2) INSULATING JACKET

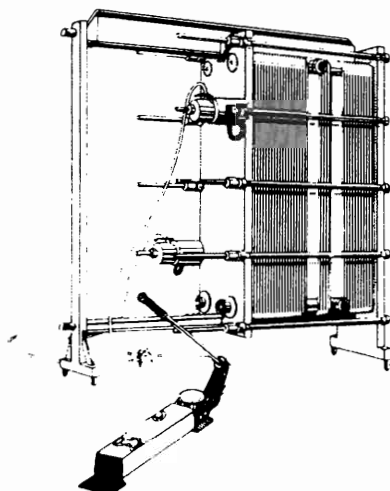


6.2.3) CLAMPING TOOLS

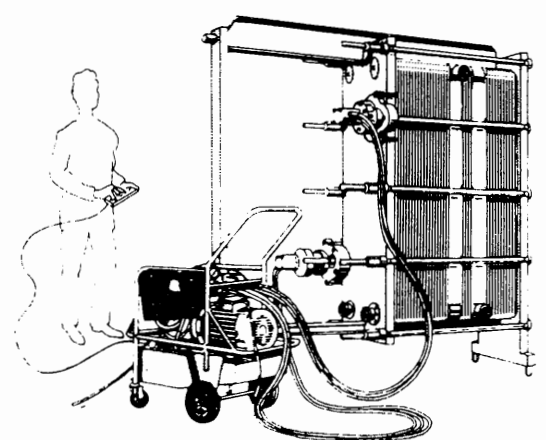
Ratchet spanner



Nut tightener - hydraulic



Nut tightener - electro-hydraulic



ISO 9001 Certified



(株) 韓國 피에치이
Korea PHE Corporation

주 소 : 인천광역시 서구 원당동 43-2 TEL : (032) 563-7564(代) FAX : (032) 563-4282
부 소 : 부산광역시 사하구 다대동 1516-1 TEL : (051) 261-2664(代) FAX : (051) 261-2666

Head Office & Factory : 43-2, Wondang-Dong, Su-Ku, Incheon, Korea TEL: (032) 563-7564 FAX: (032) 563-4282

Busan Office & Factory : 1516-1, Dadae-Dong, Sahah-Ku, Busan, Korea TEL: (051) 261-2664 FAX: (051) 261-2666

Home page : <http://koreaphe.co.kr>

AIR COOLER INSTRUCTION MANUAL



DONG HWA PRECISION IND. CO., LTD.

C O N T E N T S

I DESCRIPTIONS

II STRUCTURES

III OPERATION

IV MAINTENANCE AND INSPECTION DURING OPERATION

V CLEANING

VI PURCHASE SPARE PARTS FOR MAINTENANCE

I . Description

The Donghwa air cooler is a heat exchanger cooling the air supplied diesel engine to the specified temperature for improvement the performance of engine. It is called fin & tube type heat exchanger and used for MAN B&W, SULZER MAIN DIESEL ENGINE and etc.

The heat removed from air is carried away by the cooling water (sea water or fresh water). The cooling water flows on the inside of the fin-tube, while air flows along the outside of the fin-tube.

We call a cooling water side as Water Side and fin-tube side as Air Side. The cooling methods of water side are differential into F.W(Fresh Water) cooling & S.W (Sea Water) cooling, and Central cooling system.

II. STRUCTURES

Air cooler mainly consists of cooler insert and casing. Cooler insert is made up of tube bundle and water cover.

II-1. Tube bundle

The bundle has several multi-finned tube block arranged in the direction of the air flow. According the cooler capacity, the number of block and size of each tube block are decided.

Both ends of the finned tubes are installed in the tubesheets by tube expansion with mechanical tube expander. And special hydraulic ball expander is used for the preference adherence of fin and tube. Fin-tube block is immortally fixed at tubesheet so that is unable to take apart each other.

The two side plates serve for protecting the finned-tube and for reinforcing the cooler performance by preventing air by-pass.

II-2 WATER COVER

Water cover has water inlet & outlet nozzle, partition plate for controlling water pass, air vent & water drain connection and chemical cleaning. And there is two jack bolt to easily detach cover from bundle for cleaning. Two water covers, the channel and reversing cover, are tightly bolted to corresponding tubesheet with gasket. Here water inlet & outlet nozzle detached cover is called channel cover and the opposite cover is called reversing cover. When the cooling medium is sea water, there is zinc anode or soft iron on water cover inside to protect cover from corrosion. The corrosion protecting medium, zinc anode or soft iron, is connected as flange type to exchange it when it was wear away and is bolted with gasket to water cover.

III OPERATION

III-1 Cooling Water Side

The bundle is to be filled with water and at the same time the air vent valve is to be opened so that the air in the bundle can escape through it. There is no more air bubbles in the escaping cooling water (it means air vented completely and the bundle has been filled with water), close the air vent valve tightly. If air remains in the tubes, which will not only deteriorate the performance, but also may cause accidents during operation, so that special care is required. After the cooler is filled with water completely, it may be O.K to operate the air cooler. When the pressure and temperature reach the normal operating condition, confirm that there are no abnormalities in regard to bolts, nuts, and gaskets. If water should be leaking from the gaskets, retighten the bolts and nuts. Continuously water leak even after retightening, the gasket should be exchanged for a spare gasket.

During operation, do not exceed the permitted condition. If do exceed, contact us and consider the operation condition. If you don't, we don't take the responsibility of resulting problem.

III-2 Air Side

Make sure that the operation on the cooling water side is normal, and then the cooler is fed with air. When the operating temperature has been reached, check on the air leakage. The charged air temperature inlet and outlet of the cooler is checked up and the cooling water quantity is to be corrected, if required. After operation start for the air side, once more confirm that the connections of the cooling water side and the air side are secure.

III-3 Operation Stop

When stop the operation, first stop the air side and then the cooling water side.

When stop period will continue several days, open the drain valve in the cover and drain all water from the cooler to prevent from corrosion and freezing during the winter.

III-4 Cooling Water Velocity

Cooling water velocity is limited in view of erosion, corrosion, and fouling so that do operate over the minimum velocity. And the best tube inside velocity is staying the recommended velocity range.

Material	Recommended velocity (m/sec)	Minimum velocity (m/sec)
Copper	1.0 ~ 1.5	1.0
Al-Brass	1.4 ~ 2.0	1.0
Copper-Nickel (9:1)	1.8 ~ 2.5	1.0
Copper-Nickel (7:3)	2.4 ~ 3.5	1.0
Steel	1.5 ~ 3.0	1.0

※Note : Please never operate at the minimum velocity for the prolonged periods to prevent causing serious fouling.

IV Maintenance and Inspection during operation

IV-1 Cooling Management

- (1) With use for a long time, various contaminations are deposited inside of tubes and fins. It cause to deteriorate the performance of the air cooler, so following items should be checked during operation

- Temperature difference between inlet and outlet side of air and water
- Pressure loss for air and water

When a pressure loss has been doubled of initial condition, execute washing and cleaning.

- (2) When running the engine at part loads as well as during maneuvering or running in winter season, the temperature or the amount of cooling water passing through the air coolers should be regulated so that the air temperature at the outlet of the cooler does not drop too low. If the air is cooled down to a dew point temperature, considerable amount of condensed water will collect in the air receiver. If the charged air temperature is above the dew point, condensates will form only where the air comes in contact with surface whose temperature is below the dew point. At this time, it is advisable to control the cooling water source temperature by adjusting circulation valve but inevitably if the cooling water quantity for the air cooler is controlled, the outlet valve should be throttled.

IV-2 Electrochemical Corrosion Protecting Metal

When the cooling water is sea water, a protection metal is installed inside the cover of the air cooler to protect the cooler from corrosion.

In order to protect the electrochemical corrosion of the cooler, the anode plates are installed in the cover. When operation is continued after the protection metal has been used up, notable corrosion will occur for the cover in case of standard equipment or for the tubes and tube plates when the cover is equipped with anticorrosion rubber lining etc., so that this metal should be periodically and should be replenished as required. The anode plate has to be exchanged for new one regularly. Generally the consumption of the anode plate in new cooler is very fast. So the first exchanging has to be done within 6 months. After that time the exchanging intervals are decided in accordance with the degree of the consumption

on the last inspection.

Care should be taken that the surface of the protection metal and the threaded part are free of oil, paint, etc.

IV-3. Cover Coating Management

At the inside of the cover is coated with tar epoxy resin, neoprene lining, etc to protect the cover from corrosion by the cooling water, the inside coating should be inspected when the cover detached for inspection, cleaning, etc. If there is any damage, it should be repaired immediately. If you don't, local corrosion will occur at the damaged part, and finally the cover will be destroyed.

And also when you detach the cover, careful handling is required so that the surface will not be damaged.

IV-4. Use of the plug

When the tubes are broken because of corrosion or for some other reason, use the accessory plugs to plug both ends of the tube. The plug should be installed according to the followings

- (1) Drain the water completely from the cover.
- (2) Detach the cover installation bolts and nuts, and detach the cover. When it is difficult to detach the cover from the casing, the jack bolts should be used.
- (3) Drive the plug into both ends of the broken tube.

IV-5 Inspection

Normal hydro test pressure of water side is 6Kg/cm^2 . And air side test is done during operation whether leak or not. and general test pressure is 3Kg/cm^2 .

The holding time of air side and water side pressure test is 30 minutes. Only clean fresh water is used for the water pressure test of the cooler. Add soluble ferrous sulphate($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$) to stimulate generating the protective film at new cooler. The quantity of soluble ferrous sulphate is 1ppm per hour.

It takes a time to be generating the protective film at new cooler tubes. So it is very harmful directly to contact tube with dirty harbour water. If dirty harbour water contact, the dirt film immediately generate on tube and will hinder the build-up of a protective layer.

V Cleaning

Use the cooler for a long time, various contaminations are deposited inside of tubes and fins. It cause to deteriorate the performance of the cooler. Check the cooler outlet air temperature and if it is increased considerably , and water side pressure loss is doubled when compared initial condition, you must execute cleaning.

Water side cleaning of the bundle should be carried out, if a considerable increase in air temperature measured at the outlet of the cooler. Keep in mind that a slight fouling at the water side is too much influencing to air cooler performance. Air side cleaning of the bundle should be carried out if the pressure loss of the cooler has been about double of the initial condition.

V-1. Water side Cleaning

(1) Use Brushing Tools

- ① Turn off the blower
- ② Close the cooling water supplying valves and discharge pipe valves
- ③ Open the drain valve so that the bundle is to be empty.
- ④ Disconnect pipelines, and take off the both water covers using the jack bolts, if necessary.
- ⑤ If the unit comprises zinc protection plates or soft iron, these should be examined for their condition when water covers are detached. Damaged or wore down zinc plates or soft iron have to be exchanged new ones. The

cover has to be sandblasted and given a new coat of tar epoxy, if the damaged cover area is large. Covers made of bronze or gunmetal don't need protective coats of paint and zinc protection plates but at that case soft iron is usually used for generating protective film on the tube surface.

- ⑥ Using the provided nylon brush tool, clean all tubes while they are still wet.
- ⑦ Rinse each tube with water to remove the brushed off dirt.
- ⑧ And then it is make sure that the tube inside is clean, and replace the covers and gasket after checking up the water side connections again.
- ⑨ After completely reassembled, operate water pump and do hydrotest to check leaking.
- ⑩ All work is done, open valves and operate the cooler.

(2) Chemical cleaning

When it is impossible to remove the fouling with tube brush, it is effective to circulate chemical cleaning solution. But, it take a considerable cautions, because if chemical cleaning fails, the tubes and others will be damaged, resulting in shortening the life of apparatuses remarkably. After finishing chemical cleaning, circulate fresh water so that cleaning solution is not remain in the cooling water. If you have no experience in chemical cleaning, consult the manufacturer.

Chemical cleaning should be carried out by circulating method as built-in or by dipping the bundle into some cleaning solution after pull out it from the casing or between the air ducts. Working methods are following

- ① Turn off the blower
- ② Close the cooling water supplying valves and discharge pipe valves
- ③ Open the drain valve so that the bundle is to be empty.
- ④ Mix the chemical solution with water to specific concentrate, and sufficient amount as calculated water side volume.
- ⑤ Connect circulation pump and chemical tank at chemical connection on water cover. And then run pump and circulate solution.
- ⑥ When chemical cleaning has been done, stop pump and drain the solution through drain valve.
- ⑦ After solution draining, add neutralizer at chemical tank and neutralizing the remained solution.

⑧ Finish all of above steps, check again and run the cooler.

V - 2. The Air Side Cleaning

- (1) At moderation condition, it is possible to clean out by washing with hot water and compressed air.
- (2) But there are some deposits such as oil, grease, carbon, etc., it is preferable to clean it with steam blasts(3~7 kgf/cm², 150℃ of less) or hot water and compressed air.
- (3) It is impossible to clean by above, chemical cleaning must be carried out. Detach the bundle from the casing and dip it in cleaning solution. Chemical cleaning method is available as built-in by circulation of solution, when the cleaning system is equipped on board. After the bundle has been cleaned, it should be thoroughly flushed, dried, and properly reassembled.
Consideration should be taken to choose the chemical solution and cleaning process and must follow the guidance of chemical supplier not to attack tube or fin material.
- (4) When all work is done, you should add neutralizer and dissolve the remaining solution

V-3. Recommended chemical agent and supplier

	Chemical	Supplier
FOR WATER SIDE	SAF-ACID	= Drew Ameroid Japan Co., Ltd. Minato Ise Bldg. 12-1, 3-Chome, Kaigan-Dori, Naka-ku, Yokohama-si, Xanagwa-Ken, 231, Japan Phone : 045 - 212 -4741 Faxsimile : 045 - 212 - 4754 = Drew-Chemical
FOR AIR SIDE	ACC9	= Drew Ameroid Japan Co., Ltd. = Drew Chemical Co. New York, USA

※ Please consult chemical supplier's description.

VI Purchase Spare Parts for Maintenance

During operation period, exchanging from old parts into new ones is necessary for maintenance. For purchase, you know the detail structures and if necessary, refer to section II Structures and attached drawing.

The air cooler's parts names are tube bundle, water cover, gasket or packing, bolt, nut, anode, anode cover.

The ordering methods are following

- 1) See the nameplate and write down followings

SHIP NO., MANUFACTURE NO.

MANUFACTURING DATE, CLASS

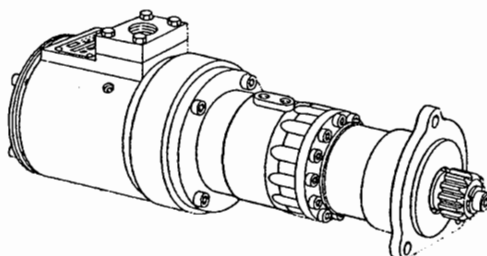
If there is not name plate or hard to see, you can also find at left or right side of tubesheet.

- 2) Check 1) and numbers and names that you need parts.
- 3) Contact us by in person, mail, telephone, or fax and inform us.
- 4) Reconfirm your ordering list.

Tel. +82 - 051 - 970 - 1110, +82 - 051 - 970 - 1112

Fax. +82 - 051 - 970 -1111, +82 - 051 - 970 - 1031

SERVICE MANUAL



MODEL: T50-Y ***TURBOTWIN* Engine Air Starter**

AIR ONLY

SECTION 1.0 INTRODUCTION

1.1 GENERAL INFORMATION

This manual provides information for servicing, disassembly, and re-assembly of the TDI Turbotwin T50-Y air starter. If there are questions not answered by this manual, please contact your local TDI distributor or dealer for assistance. Illustrations and exploded views are provided to aid in disassembly and re-assembly.

The TDI Turbotwin T50-Y engine air starter is specially designed for starting today's automated, low-emission engines. The Turbotwin uses aerodynamic speed control, allowing for cranking torque throughout the start cycle.

The Turbotwin T50-Y air starter is suited to operate within a wide range of inlet pressures and ambient temperatures. This starter is designed for operation on compressed air only.

The robust turbine motor design in the T50-Y air starter has no rubbing parts and, therefore, is tolerant of hard and liquid contamination in the supply air.

As with all TDI air starter products, there are no rubbing parts so there is no lubrication required. This eliminates failures due to lubricator problems, the expense of installing and maintaining the system, and the messy and hazardous oil film around the starter exhaust. The starter is factory grease packed for the life of the starter so it requires no maintenance.

Please review the rest of this manual before attempting to provide service on the TDI Turbotwin T50-Y air starter.

1.2 WARNINGS, CAUTIONS, & NOTES

Throughout this manual, certain types of information will be highlighted for your attention:

WARNING - used where injury to personnel or damage to equipment is possible.

CAUTION - used where there is the possibility of damage to equipment.

NOTE - use to point out special interest information.

1.3 DESCRIPTION OF OPERATION

The Turbotwin T50-Y air starter is powered by a two stage axial flow turbine coupled to a simple planetary gear reduction set. The T50-Y air starter incorporates a pre-engaged drive coupled to the starter gearbox drive train to provide a means of disengaging the pinion from the engine's ring gear.

The high horsepower of the turbine air motor combined with the planetary gear speed reducer results in a very efficient and compact unit. The Turbotwin T50-Y air starters can be used over a wide range of drive pressures from 40 psig (2.7 BAR) to 120 psig (8 BAR) and are suitable for operation on compressed air.

The T50-Y weighs approximately 34 pounds (15 KG) and is capable of delivering over 45 HP (33.6 kW) of cranking power at the maximum pressure of 120 psig (8 BAR).

1.4 INSTALLATION AND SERVICE

It is important to properly install and operate the TDI T50-Y air starter to receive the full benefits of the turbine drive advantages. It must be installed in accordance with the instructions provided by Tech Development, Inc. (TDI).

WARNING

Failure to properly install the starter or failure to operate it according to instructions provided by TDI may result in damage to the starter or engine, or cause personal injury. **DO NOT OPERATE THIS STARTER UNLESS IT IS PROPERLY ATTACHED TO AN ENGINE.**

Repair technicians or service organizations without turbine starter experience should not attempt to repair this starter until they receive factory approved training from TDI, or its representatives. Proper operation and repair of your TDI Turbotwin will assure continuous reliability and superior performance for many years.

TDI TURBOTWIN™

FROM TECH DEVELOPMENT INC.

1.5 NAMEPLATE INFORMATION

The nameplate located on the turbine housing provides important information regarding the construction of your T50-Y air starter, refer to *Figure 1*. The part number coding explanation, refer to *Figure 2*, can help you when talking to your distributor.

NOTE

You should always have the starter's Part Number, Serial Number, Operating Pressure, and Direction of Rotation information before calling your TDI distributor or dealer.

		TURBOTWIN™ PNEUMATIC STARTER TECH DEVELOPMENT INC.	
6800 POE AVE., DAYTON OH			
MODEL NO.	SERIAL NO.	CW(RH)	(CCW)LH)
T50Y	0110-655	X	
PART NUMBER			
T510-60051-01R			
HOUSING PROOF PRESSURE IS 600 PSIG			
MAX OPERATING INLET PRESS. 120 PSIG			
WARNING DO NOT OPERATE UNLOADED, WITHOUT EXHAUST GUARD OR WITHOUT EXHAUST FITTING			

Figure 1. TDI TURBOTWIN Nameplate

T5 10 - 60048 - 01R - 0 - 00	
MODEL T50 PRODUCT NUMBER OF NOZZLES 08= 8 NOZZLES 10= 10 NOZZLES 14= 14 NOZZLES AWING NUMBER FOR T50 MODEL TYPE 60048= T50P (PRE-ENGAGED, OUTBOARD NOSE, 11.2:1 RATIO, SAE 3 MOUNT) 60051= T50Y (PRE-ENGAGED, OVERHUNG PINION, 11.2:1 RATIO, SAE 3 MOUNT) 60052= T50Y (PRE-ENGAGED, OVERHUNG PINION, 11.2:1 RATIO, SAE 1 MOUNT) PINION CODES 01= 6/8 DP, 11T ON 12T BLANK, 2.00 PD, 20° PA 02= 8/10 DP, 12T ON 13T BLANK, 1.625 PD, 20° PA 03= 8/10P, 10T ON 11T BLANK, 1.375 PD, 20° PA 04= 3 MOD, 9T ON 9.567T BLANK, 1.063 PD, 14.5° PA 05= 3 MOD, 11T ON 11.7 BLANK, 1.299 PD, 14.5° PA 06= 3.5 MOD, 11T ON 11.64T BLANK, 1.516 PD, 14.5° PA 07= 3.5 MOD, 13T ON 13.7T BLANK, 1.791 PD, 14.5° PA 08= 8/10P, 13T ON 14T BLANK, 1.750 PD, 20° PA 09= 3.5 MOD, 15T ON 15.66T BLANK, 1.772 PD, 14.5° PA 10= USE CODE #03 (THIS IS A LH VERSION) 11= 3.5 MOD, 17T ON 17.67T BLANK, 2.343 PD, 14.5° PA 12= USE CODE #02 (THIS IS A LH VERSION) 13= 3.5 MOD, 14T ON 14.7T BLANK, 1.929 PD, 14.5° PA 14= 8/10DP, 12T ON 12T BLANK, 1.500 PD, 20° PA 15= 4.25 MOD, 11T ON 11T BLANK, 1.840 PD, 20° PA 16= 6/8DP, 12T ON 12.7T BLANK, 2.126 PD, 20° PA 17= USE CODE #01 (THIS IS A LH VERSION) 18= USE CODE #07 (THIS IS A LH VERSION) 19= 8/10 DP, 12T ON 13T BLANK, 1.625 PD, 20° PA 20= 3.5 MOD, 14T ON 14.7T BLANK, 2.026 PD, 20° PA 21= 4 MOD, 15T ON 15.65T BLANK, 2.465 PD, 0.325 CORRECTION FACTOR, 14.5° PA 22= 3.5 MOD, 14T ON 14.68T BLANK, 2.023 PD, 0.34 CORRECTION FACTOR, 14.5° PA 23= 3.5 MOD, 14T, 2.023 PD, 0.34 CORRECTION FACTOR, 20° PA	ORIENTATION OF INLET/CONTROL PORTS 00= 0 DEGREES (STD) 07= 210 DEGREES 01= 30 DEGREES 08= 240 DEGREES 02= 60 DEGREES 09= 270 DEGREES 03= 90 DEGREES 10= 300 DEGREES 04= 120 DEGREES 11= 330 DEGREES 05= 150 DEGREES 06= 180 DEGREES EXHAUST OPTIONS 0= EXHAUST SCREEN 1= (NOT AVAILABLE) 2= 2" NPT STRAIGHT 3= (NOT AVAILABLE) 4= EXHAUST CLOSURE PLATE (ECP) 5= (NOT AVAILABLE) 6= (NOT AVAILABLE) 7= (NOT AVAILABLE) 8= (NOT AVAILABLE) ROTATION R= RH (CW) L= LH (CCW)

Figure 2. T50 Series Part Number Identification

SECTION 2.0 DESCRIPTION OF BASIC GROUPS

2.1 GENERAL

The TDI Turbotwin T50-Y air starter is a lightweight, compact unit driven by a two stage turbine air motor. The starter is composed of three basic assembly groups: Turbine Housing Assembly, Gearbox Housing Assembly, and Drive Assembly.

2.2 TURBINE HOUSING ASSEMBLY

The Turbine housing assembly, refer to figure 3, consists of a stage one (16) and a stage two (6) turbine rotor mounted on sungear shaft (22). The front bearing (8) is secured by a retainer plate (20) and the aft bearing is pre-load by a spring washer (9).

The ring gear (24) is installed between the turbine assembly (19) and the gearbox housing and secured by four screws .

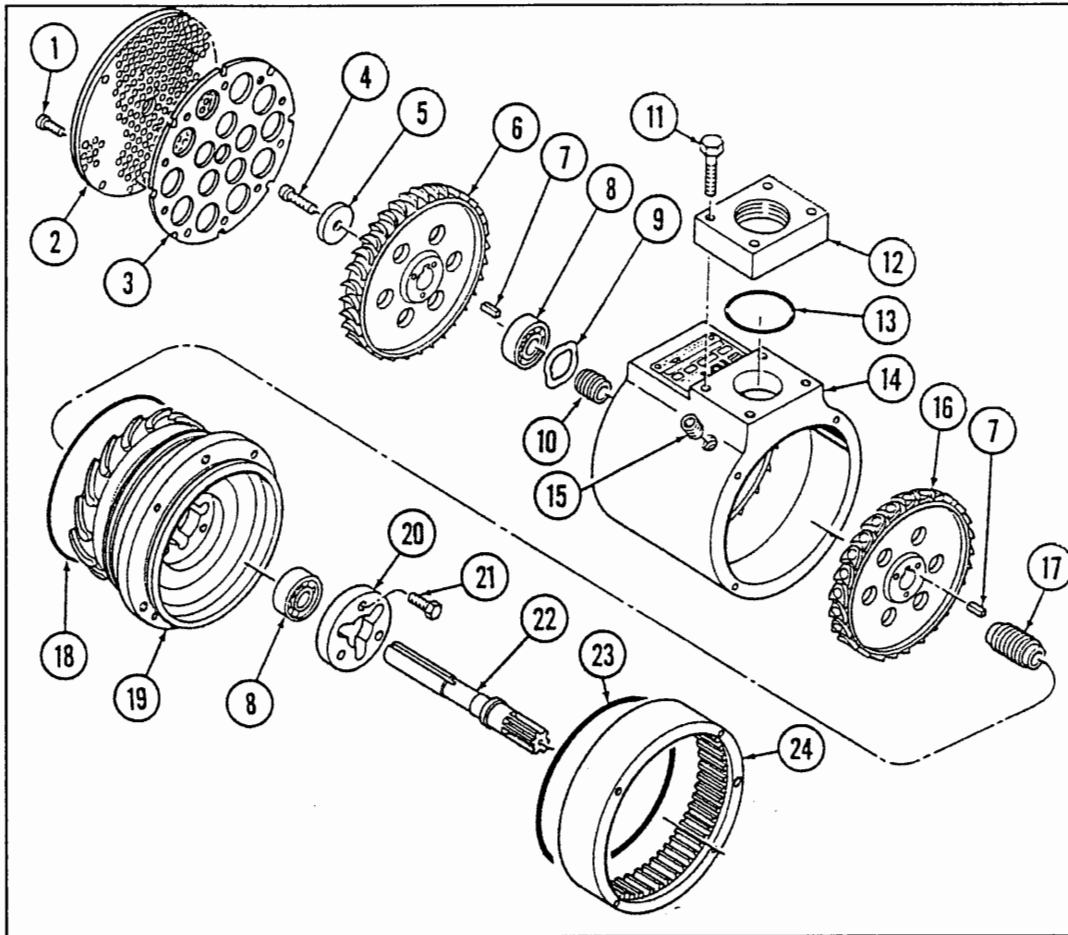


Figure 3. Turbine Housing Assembly

2.3 GEARBOX HOUSING ASSEMBLY

The gearbox housing assembly, refer to figure 4, consists of a planet gear carrier and output shaft (25), three planet gears (29), needle bearings (30), spacers (28), and planet shafts (27).

The carrier shaft (25) is mounted on a single bearing (31) in the gearbox housing (34). The retainer ring (41) secures the carrier shaft in the gearbox housing. The bearing housing (37) and pre-engaged piston (43) are installed in the gearbox housing (34).

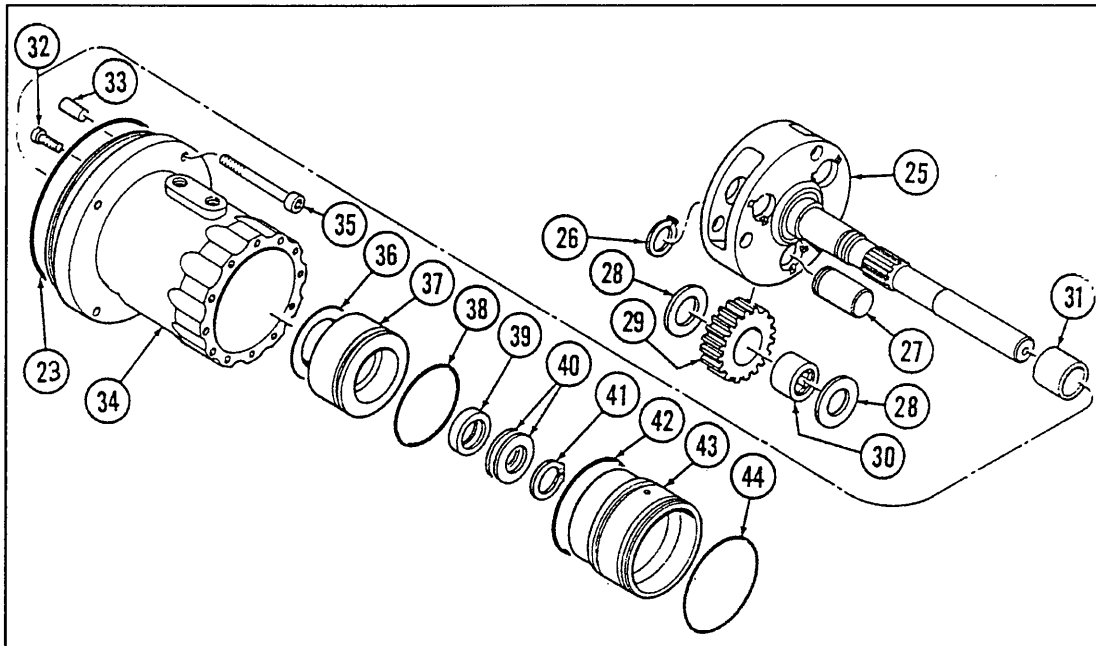


Figure 4. Gearbox Housing Assembly

2.4 DRIVE ASSEMBLY

The drive assembly, refer to figure 5, consists of a pre-engagement drive (46) and drive housing (51). Twelve screws (52) secure the drive housing to the gearbox housing. The pinion (54) is secured by screw (56).

The pre-engagement drive (46) is mounted in a needle bearing (49), which is installed in the drive housing (51).

Split rings (45) and a return spring (47) aid in the disengagement of the pinion from the engine's ring gear.

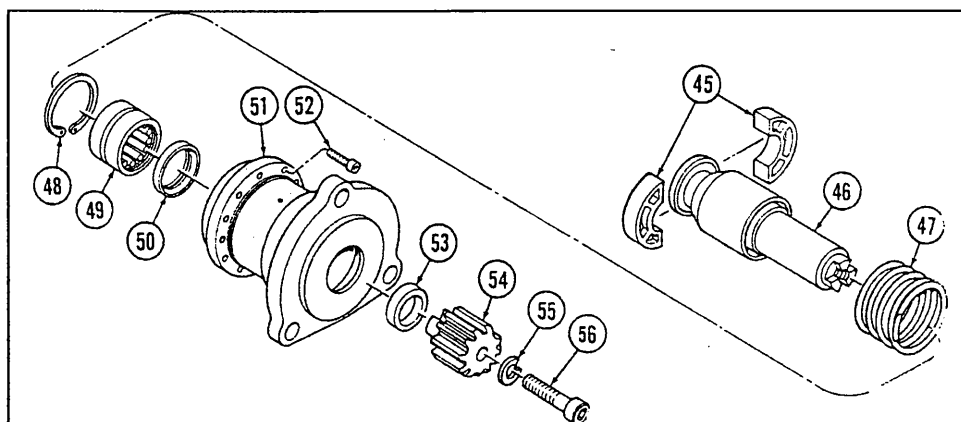


Figure 5. Drive Assembly

SECTION 3.0 DISASSEMBLY

3.1 GENERAL

Always mark adjacent parts on the starter; Nozzle 2/ Containment Ring (14), Turbine Housing (19), Gearbox Housing (34), and Drive Housing (51) so these parts can be located in the same relative position when the starter is reassembled.

Do not disassemble the starter any further than necessary to replace a worn or damaged part

Always have a complete set of seals and o-rings on hand before starting to overhaul the Turbotwin T50-Y air starter. Never use old seals or o-rings.

The tools listed in *Table 1* are suggested for use by technicians servicing the Turbotwin T50-Y air starter. The best results can be expected when these tools are used, however the use of other tools are acceptable.

TOOL DESCRIPTION	TDI/PN
Spanner Wrench	2-27272
Stage 2 Rotor Puller Tool	52-20076
Tool, Turbine Bearing	45-25294
Tool, Bearing/Seal	2-26943
Tool, Seal Positioning	45-25316

Table 1. T50 Series Service Tools (P/N: T50-28570)

3.2 DRIVE HOUSING

3.2.1 Removal of Drive Housing

Mark position of drive pinion opening relative to gearbox housing for reference during re-assembly.

Secure pinion (54) in a soft tooth vise while supporting aft end of the T50-Y air starter and rotate pinion screw (56) counterclockwise to remove.

Remove the twelve screws (52) and pull pinion housing (51) from gearbox housing (34). If pinion housing is too tight, tap it with a mallet to loosen.

Pry lip seal (50) from front side of pinion housing (51).

Remove retainer ring (48) and press needle bearing (49) from pinion housing (51) using press tool.

3.2.2 Removal of Drive

Remove return spring (47) and pinion collar (53) from carrier shaft assembly (25).

Remove split rings (45) from drive assembly.

3.3 GEARBOX HOUSING

3.3.1 Removal of Gearbox Housing

Remove the four screws (35) and separate the gearbox assembly from the turbine assembly. If the gearbox is too tight, tap it with a mallet to loosen.

3.3.2 Gearbox Disassembly

Remove snap ring (41) and two thrust washers (40) from carrier shaft (25).

Press forward side of carrier shaft to remove it from the gearbox housing.

Remove four screws (32) and press the bearing housing/pre-engaged piston assembly (37,43) from the gearbox housing.

Hand press bearing housing (37) from pre-engaged piston (43).

Elevate bearing housing and press gearbox bearing (31) to remove from housing (37).

3.3.3 Carrier Shaft/Planet Gear Disassembly

Remove snap ring (26) from planet shaft (27) and push shaft through holes in assembly (25). Refer to figure 6.

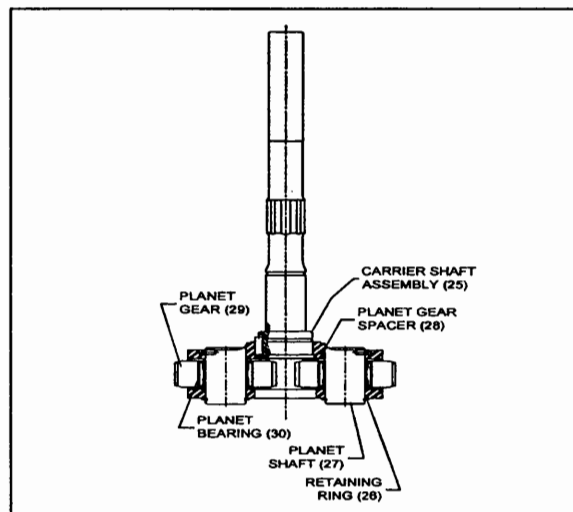


Figure 6. Carrier Shaft Disassembly

Slide the planet gear (29) from the carrier shaft and remove the two spacers (28).

Press the needle bearing (30) from the planet gear (29).

3.4 TURBINE HOUSING

3.4.1 Stage 2 Rotor Removal

Remove screws (1), exhaust guard (2), and exhaust support (3).

Secure the stage 2 rotor (6) and remove the turbine screw (4) and washer (5).

NOTE

The sun gear (22) may have to be held firmly in a soft jaw vise when removing turbine screw.

Install rotor puller tool P/N 52-20076 and remove the stage 2 rotor per figure 7.

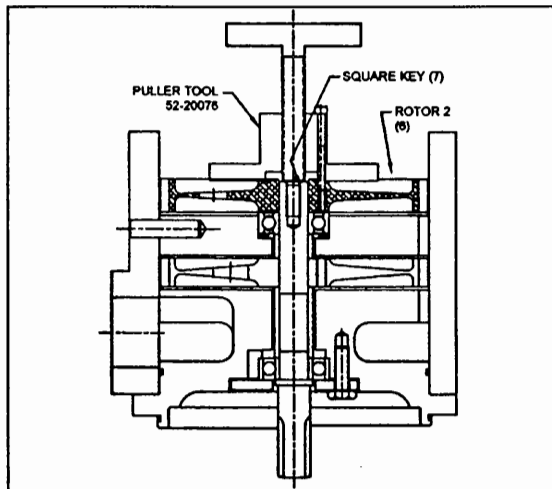


Figure 7. Turbine Rotor Removal

Remove the square key (7) from turbine shaft (22).

3.4.2 Turbine Housing Disassembly

Place the turbine on a firm surface with the sun gear end facing up.

Remove three screws (21) and bearing retainer (20) from turbine housing (19).

With the exhaust end facing up press turbine shaft (22) through turbine housing (19) as shown in figure 8.

Press turbine shaft (22) through forward bearing (8) to remove bearing from shaft.

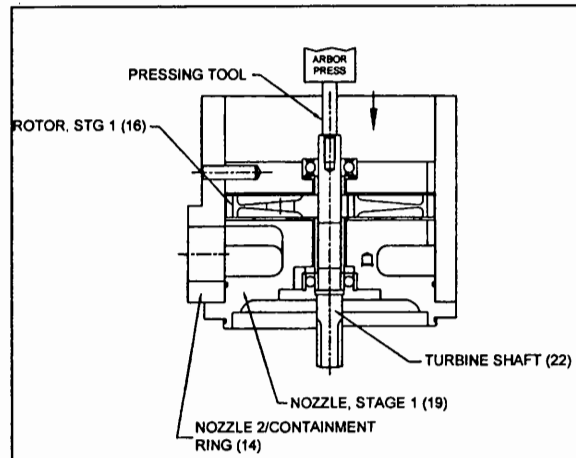


Figure 8. Turbine Shaft Removal

Remove the aft bearing (8), wavy washers (9), and labyrinth (10) from containment housing (14).

Install three screws (35) removed from the gearbox housing into the jack holes on the turbine housing (19) as shown in figure 9.

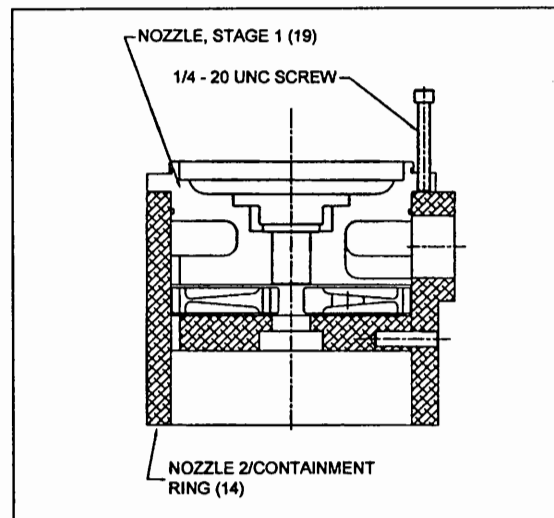


Figure 9. Nozzle 2 Removal

Turn the screws in sequence until the turbine housing (19) is completely removed from the containment housing (14).

Remove the stage 1 rotor (16) and square key (7) from containment housing (14).

SECTION 4.0 CLEANING & INSPECTION

4.1 CLEANING

Degrease all metal parts, except bearings, using a commercially approved solvent. Refer to *Table 2*.

NOTE

Never wash bendix assembly or bearings in cleaning solvents. It is recommended bearings be replaced with new parts.

Clean aluminum parts using the solutions per *Table 2*; soak for 5 minutes. Remove parts, rinse in hot water, and dry thoroughly.

Clean corroded steel parts with a commercially approved stripper.

Clean corroded aluminum parts by cleaning as stated above and then immerse the parts in chromic-nitric-phosphoric acid pickle solution per *Table 2*. Rinse in hot water and dry thoroughly.

MATERIAL or COMPOUND	MANUFACTURER
Degreasing Solvent (Trichloroethylene) (O-T-634)	Commercially Available
Acetone	Commercially Available
Aluminum Cleaning Solution	Diversey Corp., 212 W. Monroe, Chicago, IL 60606 Dissolve 5 oz of Diversey 808 per gallon of water at 155°- 165°F.
Steel Cleaner - Rust & Corrosion	Oakite Products Corp., 50 Valley Rd., Berkeley Heights, NJ 07992 Mix 3-5 lb. of Oakite rust Stripper per gallon of water; use at 160°- 180°F.
Chromic-Nitric-Phosphoric Acid Pickle Solution	Mix 8lb. of chromic acid, 1.9 gal. of phosphoric acid, 1.5 gal. of nitric acid with enough water to make a total of 10 gal. of solution.
WARNING Follow all instructions provided with the MSDS sheets on the materials and compounds listed above.	

Table 2. Cleaning Materials and Compounds

4.2 INSPECTION

Use *Table 3* as a guide to check for acceptable condition of the parts listed.

Check all threaded parts for galled, crossed stripped, or broken threads.

Check all parts for cracks, corrosion, distortion, scoring, or general damage.

Check all bearing bores for wear.

Check gear teeth and turbine housing ring gear for wear. In general, visually check for spalling, fretting, surface flaking, chipping, splitting, and corrosion. If wear is apparent, check the gear teeth dimensions in accordance with *Table 4*. Nicks and dents that cannot be felt with a .020 inch radius scribe are acceptable.

TDI TURBOTWIN™
FROM TECH DEVELOPMENT INC.

Part Description	Check For	Requirements (Defective Parts Must Be Replaced)
Drive	Worn loose or missing parts	Defective unit to be replaced. Use figure 10 as a guideline for acceptable pinion wear.
Drive Housing	Cracks and breakage	Cracks are not acceptable
Planet Gear	Cracked, chipped, worn, or galled teeth.	Wear must not exceed limits per table 4. There shall be no evidence of excessive wear.
Carrier Shaft	Cracks, scoring or raised metal in planet shaft holes and keyways. Integrity of knurl/keyed connection.	Deformation of metal (smearing) in planet pin holes & keyways not acceptable. Scoring on bearing diameter not to exceed .005" depth. Wear must not exceed limits per Table 4.
Planet Pins	Wear grooves or flat spots	Wear grooves in flat spots not permitted. Wear must not exceed limits per Table 4.
Washers	Wear grooves	Wear must not exceed limits per Table 4.
Gearbox Housing	Cracks and Breakage	Cracks and breakage not acceptable.
Sungear/Turbine Shaft	Cracks, scoring, wear grooves, chipped or broken gear- teeth, galling or scoring on bearing surface of shaft. Raised metal on the keyway.	Wear must not exceed limits per Table 4.
Spacers	Parallelism of end surfaces	Ends must be parallel within 0.0005".
Turbine Housing	Cracks and breakage	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired.
Ring Gear	Cracks, worn, chipped, or broken gear teeth.	Wear must not exceed limits per Table 4.
Needle Bearings	Freedom of needle rollers	Replace bearings
Ball bearings	Freedom of rotation without excessive play between races	Replace bearings
Containment Ring/ Nozzle	Corrosion, erosion, cracks and broken nozzle edges.	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired.
Turbine Rotors	Corrosion, erosion, cracks and broken edges.	Minor tip rub is permitted if function is not impaired.
	Bore and key way wear	Wear is not permitted.

Table 3. Parts Inspection Check Requirements

PART DESCRIPTION	LIMIT, Inches
Ring gear / Turbine Housing Internal measurement between two .072" diameter pins.	4.6655 max.
Sun Gear / Turbine Shaft Bearing diameter External measurement over two .072 diameter pins. 11.2:1	.5566 min
Planet Gear External measurement over two .085" diameter pins. 11.2:1	2.2217 min

Table 4. Parts Wear Limits

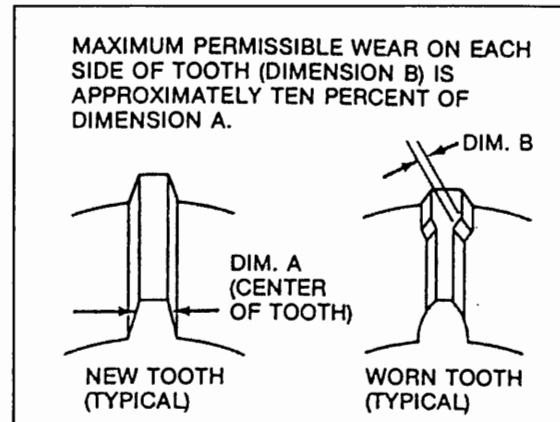


Figure 10. Gear Teeth Wear Allowances

ITEM NUMBER *	TORQUE	
	In-lbs	Nm
4 (Screw)	170	231
11 (Screw)	75	102
21 (Screw)	113	154
32 (Screw)	81	98
35 (Screw)	150	204
52 (Screw)	150	204
56 (Screw)	1590	2162

* Refer to section 6 for part number identification.

Table 5. Torque Values

SECTION 5.0 ASSEMBLY

5.1 GENERAL INFORMATION

The tools listed in *Table 1* are suggested for use by technicians servicing the Turbotwin T50-Y air starter. The best results can be expected when these tools are used, however the use of other tools is acceptable.

CAUTION

Replace all screws, o-rings, lip seals, and bearings. These parts are included in the overhaul kit shown in the Parts List, Section 6.0.

NOTE

Always press the inner race of a ball bearing when installing a bearing onto a shaft. Always press the outer race of a ball bearing when installing into a housing. DO NOT LOAD BEARING BALLS

Lubricate all o-rings with petroleum jelly or Parker O-ring Lube before assembly. Refer to *Table 5* for a list of materials to be used during assembly.

MATERIALS	SOURCE
Petroleum Jelly	Commercially Available
Parker-O-Ring Lube	Commercially Available
Aeroshell #6 Grease	Commercially Available
Loctite RC290	Commercially Available
Grease, gearbox	TDI P/N 9-94121-001

Table 6. Materials for Assembly

5.2 TURBINE HOUSING

5.2.1 TURBINE BEARING INSTALLATION

Press the turbine bearing (8) onto the turbine shaft (22) until seated.

Press the turbine bearing/shaft assembly (8,22) into the turbine housing (19). Use press tool P/N 2-26943 if required per figure 11. Do not press on the end of the shaft because the load could damage the bearing balls.

Install the bearing retainer (20) into the turbine housing (19) and secure with three screws (21) Torque to 75 in-lbs.

Install o-ring (18) onto aft end of turbine housing (19).

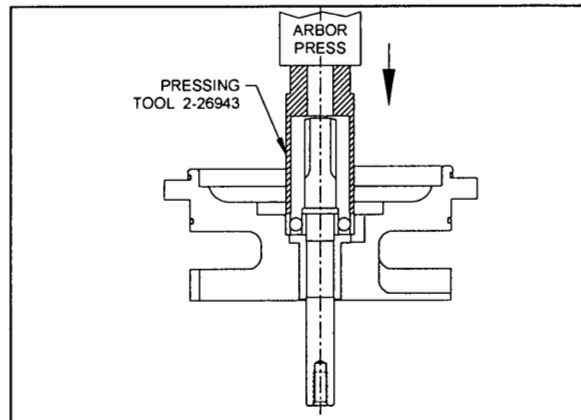


Figure 11. Turbine Bearing / Shaft Installation

5.2.2 ROTOR 1 INSTALLATION

Turn the turbine nozzle over (exhaust end up) and install the labyrinth (17) onto the shaft.

Press the square key (7) into the keyway of turbine shaft (22) until seated.

Install stage 1 rotor (16) by sliding over turbine shaft (22), while simultaneously aligning the key with the keyway in the rotor. Check for proper orientation as this rotor can be installed backwards.

5.2.3 STAGE 2 NOZLE INSTALLATION

Install turbine housing (19) into nozzle 2 containment housing (14).

NOTE

The air inlet port on nozzle 2 must be aligned with the casting indentation on the turbine housing.

5.2.4 ROTOR 2 INSTALLATION

Turn the turbine nozzle over (exhaust end up) and install the labyrinth (10) onto the shaft.

Install pre-load springs (9) into bearing bore of nozzle 2 containment housing (14).

Apply a light coating of oil to the bearing bore in the Nozzle Containment Assembly and press the turbine bearing (8) over the turbine shaft and into the bearing bore using press tool P/N. 2-26943

Insert key (7) into turbine shaft keyway and install stage 2 rotor (6) onto shaft while simultaneously aligning the key with the keyway in the rotor. Check for proper orientation as this rotor can be installed backwards.

Secure stage 2 rotor with rotor washer (5) and rotor screw (4). Torque to 170 in-lb.

Install exhaust support (3) and exhaust guard (2) and secure with eight screws. Torque to 150 in-lb.

Turn turbine housing over and install o-ring (23) into the o-ring groove on forward side of turbine housing (19).

If removed, install plug (15) into nozzle 2 containment housing.

Install the ring gear (24) onto turbine housing with the dowel pin hole facing up.

Install dowel pin (33) into dowel pin hole in ring rear.

5.3 GEAR BOX ASSEMBLY

5.3.1 PLANETARY GEAR CARRIER ASSEMBLY

Press needle bearings (30) into planet gears (29) using arbor press. The bearing ID stamping must be against pressing tool. The bearing should be centered between gear faces.

Place thrust washer (28) on each side of planet gear (29) and install into carrier shaft (25) slot.

Install planet shaft (27) into forward side of carrier and secure with snap ring (26). Be sure the anti-rotation pin is inserted into the slot on the carrier shaft.

5.3.2 CARRIER SHAFT INSTALLATION

Install o-ring (36) into forward side of gearbox housing (34).

If removed, press gearbox bearing (31) into aft side of bearing housing (37).

Press the lip seal (39) into the forward side of the bearing housing (37) until seated using press tool P/N: 2-26943.

Install o-ring (38) into the groove on the bearing housing (37).

NOTE

Apply a small amount of Aeroshell grease to the outer surface of the bearing hub and the inside wall of the gearbox.

Install the bearing housing assembly (36,37,38) in the forward side of the gearbox housing (34) and secure with four screws (32). Torque to 81 in-lb.

Install two o-rings (42,44) into the grooves on the pre-engaged piston (43).

NOTE

Apply a small amount of Aeroshell grease to the outer and inner surface of the pre-engaged piston.

Hand press pre-engaged piston into the forward side of the gearbox housing and remove any excess grease from gearbox housing.

Install o-ring (23) onto aft end of gearbox housing (34).

Install lip seal tool PN: 45-25316 into forward side of gearbox housing (34) placing tapered end of tool into lip seal (39).

Install gearbox housing onto carrier shaft and remove lip seal tool when gearbox is firmly seated on carrier shaft assembly.

Place two thrust washers (40) on carrier shaft and secure with snap ring (41).

5.3.3 DRIVE INSTALLATION

Apply a small amount of Aeroshell # 6 grease to split rings (45) and install split rings onto drive assembly (46).

Install the drive assembly (46) onto carrier shaft and place return spring (47) over drive assembly.

Press needle bearing (49) into aft end of pinion housing (51) and secure with retainer ring (48).

Press lip seal (50) into forward side of pinion housing (51).

5.4 FINAL ASSEMBLY

Temporarily install one screw (35) into ring gear (24) to prevent it from rotating while applying grease.

Apply liberal amounts of grease (100 grams) to planet gears (29), turbine shaft sun gear (22) and ring gear (24). Remove screw (35) installed in above step.

Align gearbox assembly with turbine assembly and fasten together with four screws (35). Torque to 113 in-lbs.

Install pinion housing (51) onto gearbox housing (34) and secure with twelve screws (52). Torque to 150 in-ft.

Install pinion collar (53) onto drive shaft (46).

Install pinion (54) onto drive shaft and secure with washer (55) and screw (56). Torque screw to 60 ft-lb. Apply Loctite 242 to screw before installing. Note: Pinion must be held in place to tighten screw (56). A soft tooth vise can be used to secure pinion, however, be careful not to damage pinion.

SECTION 6.0 PARTS LIST

The components illustrated and/or described in this section are for the Turbotwin T50-Y air starter. When rebuilding a T50-Y air starter, it is recommended to purchase and completely install the appropriate service kit.

T50-Y ILLUSTRATED PARTS LIST				
				Overhaul Kit
ITEM #	DESCRIPTION	PART NUMBER	QTY.	T50Y-28826
1	Screw	14F-25020-014	8	√
2	Exhaust Guard	2-28380	1	
3	Exhaust Support	2-27475	1	
4	Screw, Rotor Attachment	19F-25028-012	1	√
5	Rotor Washer	9-93047	1	
6	Stage 2 Rotor	2-27232	1	
7	Square Key (1/8")	9-90220-050	2	
8	Turbine Bearing	9-91224	2	√
9	Bearing Pre-Load Spring	9-90439	2	√
10	Spacer / Labyrinth	2-28445	1	√
11	Screw	71F-31218-020	4	
12	Inlet Flange	2-28593	1	
13	This O-Ring is no longer required	9-90001-031	1	
14	Containment, Nozzle 2, RH	2-28359-00R	1	
14	Containment, Nozzle 2, LH	2-28359-00L	1	
15	Hollow Hex Plug	9-93501-002	1	
16	Stage 1 Rotor	2-27225	1	
17	Spacer/Labyrinth	2-28444	1	√
18	O-Ring	9-90001-047	1	√
19	Turbine Hsg. / Stage 1 (10 Noz. RH)	2-28354-10R	1	
19	Turbine Hsg. / Stage 1 (10 Noz. LH)	2-28354-10L	1	
19	Turbine Hsg. / Stage 1 (14 Noz. RH)	2-28354-14R	1	
19	Turbine Hsg. / Stage 1 (14 Noz. LH)	2-28354-14L	1	
20	Bearing Retainer	2-28446	1	
21	Screw	71F-25020-012	3	√
22	Turbine Shaft 11.2:1)	2-28339	1	
23	O-Ring	9-90001-047	2	√
24	Ring Gear	2-28430	1	
25	Carrier Shaft Assembly	2-28358-001	1	
26	Retaining Ring	9-92001-001	3	

TDI TURBOTWIN™

FROM TECH DEVELOPMENT INC.

27	Planet Shaft	2P-20182	3	
28	Planet Gear Spacer	9-93004	6	√
29	Planet Gear (11.2:1)	2-28316	3	
30	Planet Bearing	9-91004-001	3	√
31	Gearbox Bearing	9-91405	1	√
32	Screw	14F-19024-012	4	√
33	Dowel Pin	9-91502-007	1	
34	Gearbox Housing	2-28352	1	
35	Screw	14F-25020-044	4	√
36	O-Ring	9-90001-035	1	√
37	Bearing Hub	2-24114	1	
38	O-Ring	9-90002-331	1	√
39	Lip Seal	2-23810	1	√
40	Thrust Washers	9-93085	2	√
41	Retaining Ring	9-92001-025	1	√
42	O-Ring	9-90002-336	1	√
43	Pre-engage Piston	2-24644-001	1	
44	O-Ring	9-90002-234	1	√
45	Split Rings	2-23419	2	√
46	Drive	2-27254	1	
47	Return Spring	9-90430	1	
48	Retainer Ring	9-92001-011	1	
49	Roller Bearing	9-91422	1	√
50	Lip Seal	2-22084	1	√
51	Pinion Housing (SAE 3)	2-28552	1	
52	Screw	14F-25020-016	12	√
53	Collar, Pinion	2-23908	1	
54	Code 01: 6/8P, 12/11T, 20 PA, RH	2-23910-001	1	
54	Code 05 - 3 Mod, 11T, 14.5 PA, RH	2-23910-005	1	
54	Code 06 - 3.5 Mod, 11T, 14.5 PA, RH	2-23910-006	1	
54	Code 11 - 3.5 Mod, 17T, 14.5 PA, RH	2-23910-011	1	
54	Code 21 - 3.5 Mod, 15T, 14.5 PA, RH	2-23910-021	1	
54	Code 22 - 3.5 Mod, 15T, 14.5 PA, LH	2-23910-022	1	
55	Washer	9-93001-013	1	√
56	Screw, Pinion attachment	11F-50020-32	1	√

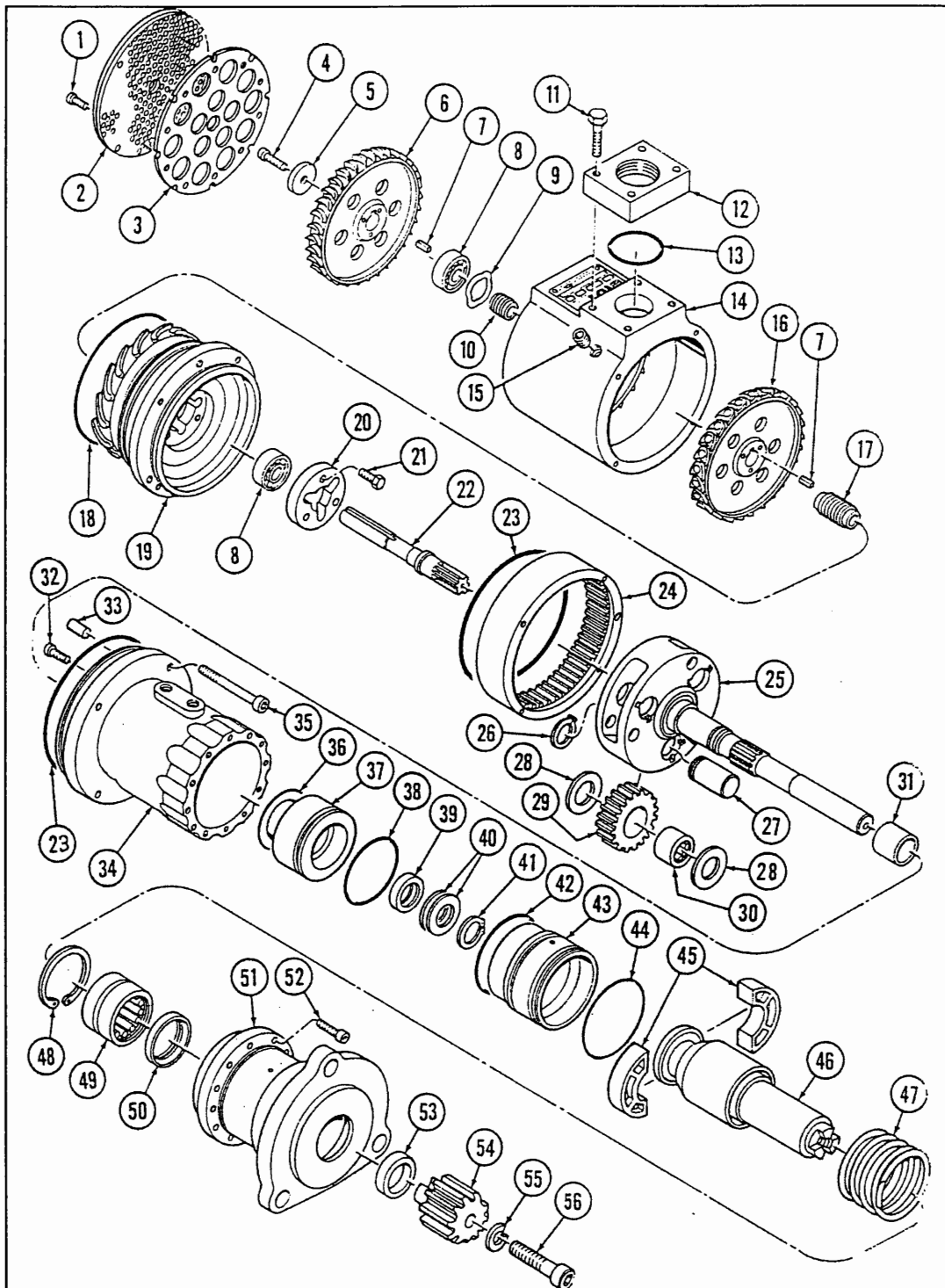
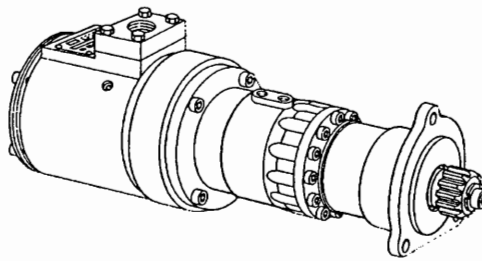


Figure 12. Exploded view of T50-Y TURBOTWIN air starter

ILLUSTRATED PARTS BREAKDOWN



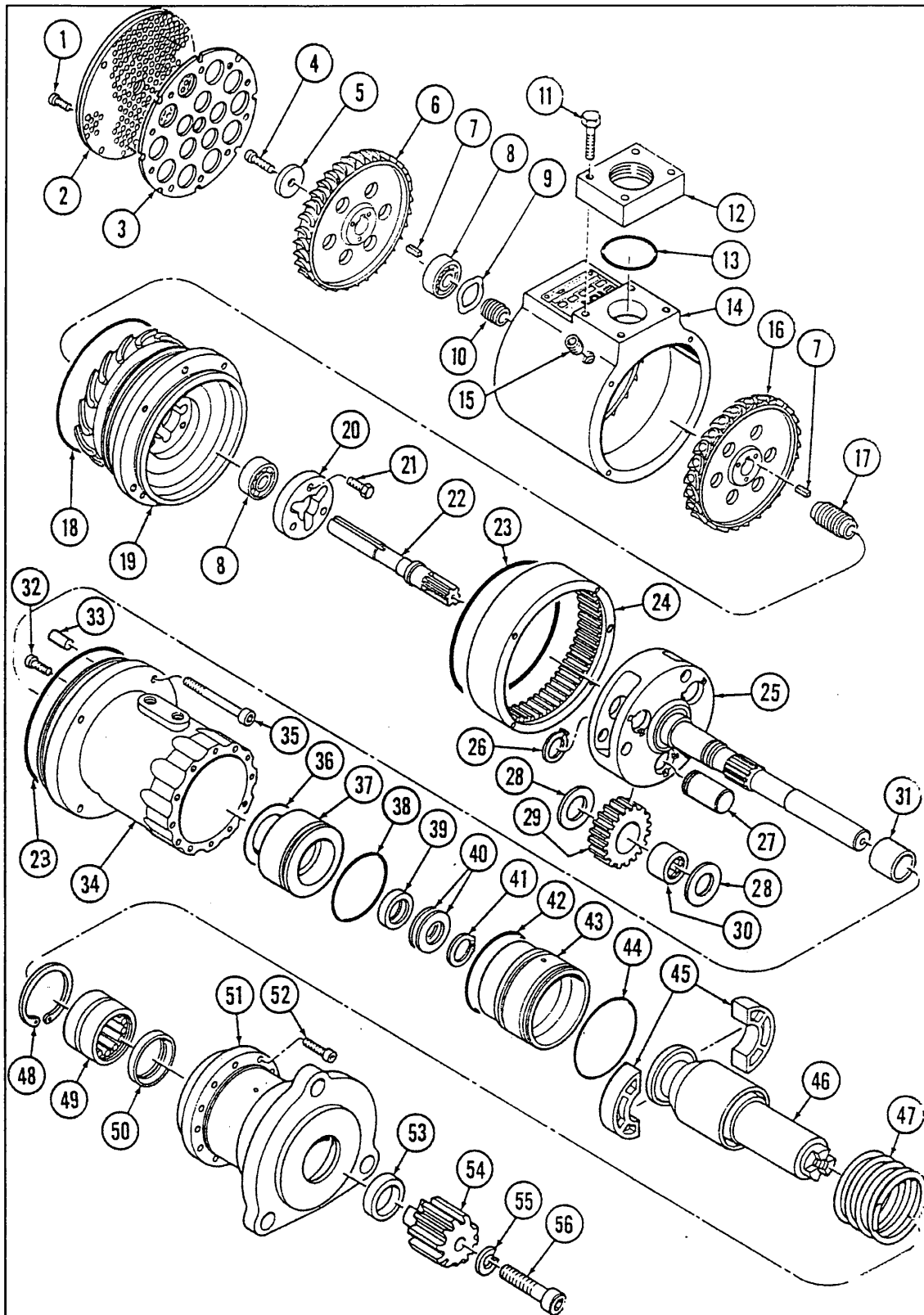
MODEL: T50-Y *TURBOTWIN* Engine Air Starter

IMPORTANT NOTE

The purpose of this illustrated parts breakdown is to provide part number identification of the various components of the listed starters. Only those parts which may be disassembled at the field or repair shop level are broken out and identified. Certain parts or components are "factory only" assemblies, and should not be disassembled below the level shown in this document. Do not disassemble or reassemble the starter without referring to the proper TDI TURBOTWIN service manual. The use of improper procedures, non-authorized replacement parts or incorrect tools, may result in a faulty operating starter which could affect its performance or create a hazardous condition.

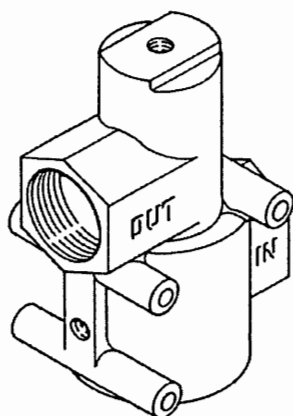
	T50-Y ILLUSTRATED PARTS LIST			
				Overhaul Kit
ITEM #	DESCRIPTION	PART NUMBER	QTY.	T50Y-28826
1	Screw	14F-25020-014	8	√
2	Exhaust Guard	2-28380	1	
3	Exhaust Support	2-27475	1	
4	Screw, Rotor Attachment	19F-25028-012	1	√
5	Rotor Washer	9-93047	1	
6	Stage 2 Rotor	2-27232	1	
7	Square Key (1/8")	9-90220-050	2	
8	Turbine Bearing	9-91224	2	√
9	Bearing Pre-Load Spring	9-90439	2	√
10	Spacer / Labyrinth	2-28445	1	√
11	Screw	71F-31218-020	4	
12	Inlet Flange	2-28593	1	
13	This O-Ring is no longer required	9-90001-031	1	
14	Containment, Nozzle 2, RH	2-28359-00R	1	
14	Containment, Nozzle 2, LH	2-28359-00L	1	
15	Hollow Hex Plug	9-93501-002	1	
16	Stage 1 Rotor	2-27225	1	
17	Spacer/Labyrinth	2-28444	1	√
18	O-Ring	9-90001-047	1	√
19	Turbine Hsg. / Stage 1 (10 Noz. RH)	2-28354-10R	1	
19	Turbine Hsg. / Stage 1 (10 Noz. LH)	2-28354-10L	1	
19	Turbine Hsg. / Stage 1 (14 Noz. RH)	2-28354-14R	1	
19	Turbine Hsg. / Stage 1 (14 Noz. LH)	2-28354-14L	1	
20	Bearing Retainer	2-28446	1	
21	Screw	71F-25020-012	3	√
22	Turbine Shaft 11.2:1)	2-28339	1	
23	O-Ring	9-90001-047	2	√
24	Ring Gear	2-28430	1	
25	Carrier Shaft Assembly	2-28358-001	1	
26	Retaining Ring	9-92001-001	3	
27	Planet Shaft	2P-20182	3	
28	Planet Gear Spacer	9-93004	6	√
29	Planet Gear (11.2:1)	2-28316	3	
30	Planet Bearing	9-91004-001	3	√
31	Gearbox Bearing	9-91405	1	√
32	Screw	14F-19024-012	4	√
33	Dowel Pin	9-91502-007	1	

				Overhaul Kit
ITEM #	DESCRIPTION	PART NUMBER	QTY	T50Y-28826
34	Gearbox Housing	2-28352	1	
35	Screw	14F-25020-044	4	√
36	O-Ring	9-90001-035	1	√
37	Bearing Hub	2-24114	1	
38	O-Ring	9-90002-331	1	√
39	Lip Seal	2-23810	1	√
40	Thrust Washers	9-93085	2	√
41	Retaining Ring	9-92001-025	1	√
42	O-Ring	9-90002-336	1	√
43	Pre-engage Piston	2-24644-001	1	
44	O-Ring	9-90002-234	1	√
45	Split Rings	2-23419	2	√
46	Drive	2-27254	1	
47	Return Spring	9-90430	1	
48	Retainer Ring	9-92001-011	1	
49	Roller Bearing	9-91422	1	√
50	Lip Seal	2-22084	1	√
51	Pinion Housing (SAE 3)	2-28552	1	
52	Screw	14F-25020-016	12	√
53	Collar, Pinion	2-23908	1	
54	Code 01: 6/8P, 12/11T, 20 PA, RH	2-23910-001	1	
54	Code 05 - 3 Mod, 11T,14.5 PA, RH	2-23910-005	1	
54	Code 06 - 3.5 Mod, 11T,14.5 PA, RH	2-23910-006	1	
54	Code 11 - 3.5 Mod, 17T,14.5 PA, RH	2-23910-011	1	
54	Code 21 - 3.5 Mod, 15T,14.5 PA, RH	2-23910-021	1	
54	Code 22 - 3.5 Mod, 15T,14.5 PA, LH	2-23910-022	1	
55	Washer	9-93001-013	1	√
56	Screw, Pinion attachment	11F-50020-32	1	√



Exploded View of Model T50-Y TURBOTWIN Air Starter

ILLUSTRATED PARTS BREAKDOWN



TURBO VALVE (Pneumatically Controlled)

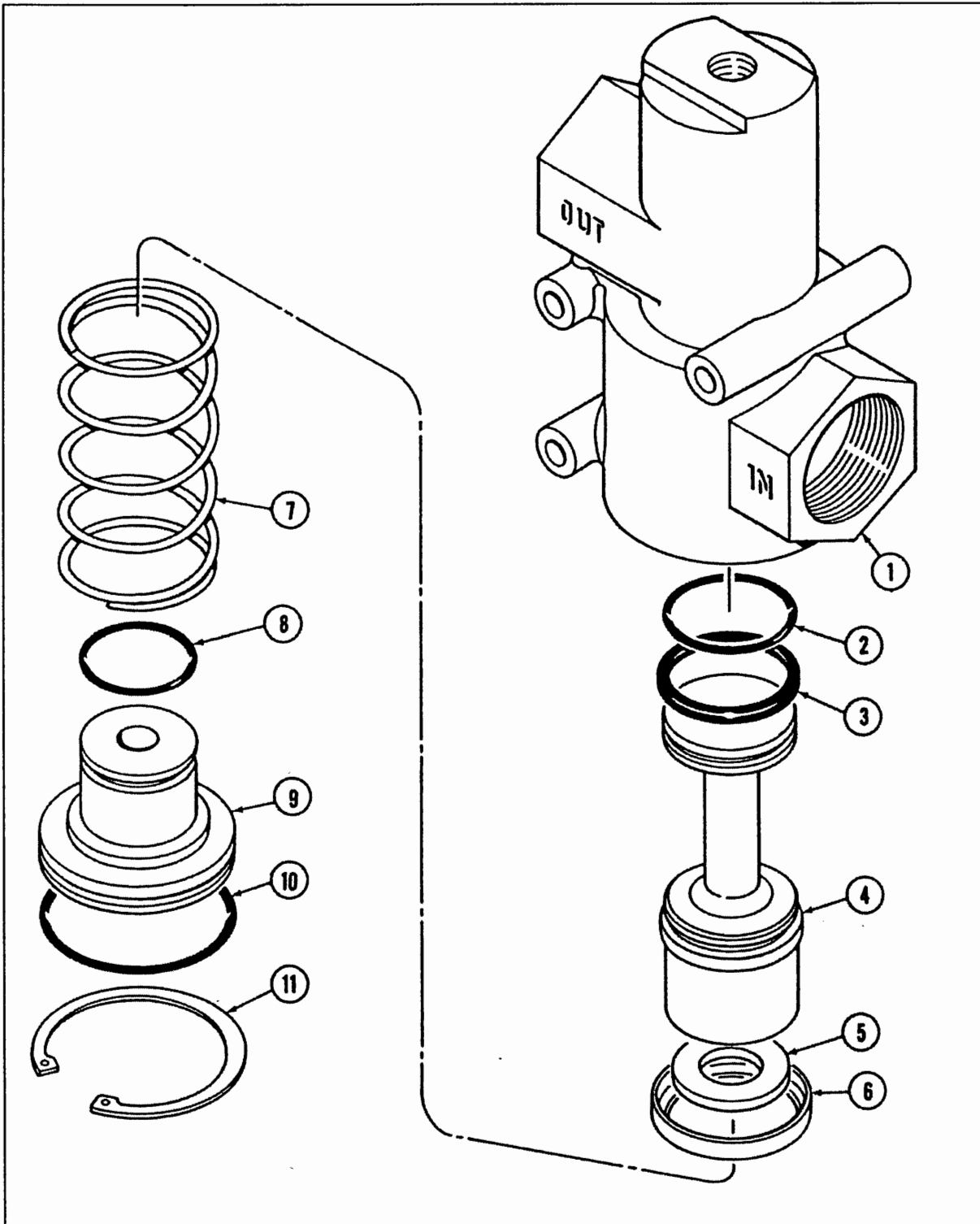
TDI TURBOVALVE™
FROM TECH DEVELOPMENT INC.

TOP ASSEMBLY PART NUMBERS COVERED IN THIS PUBLICATION

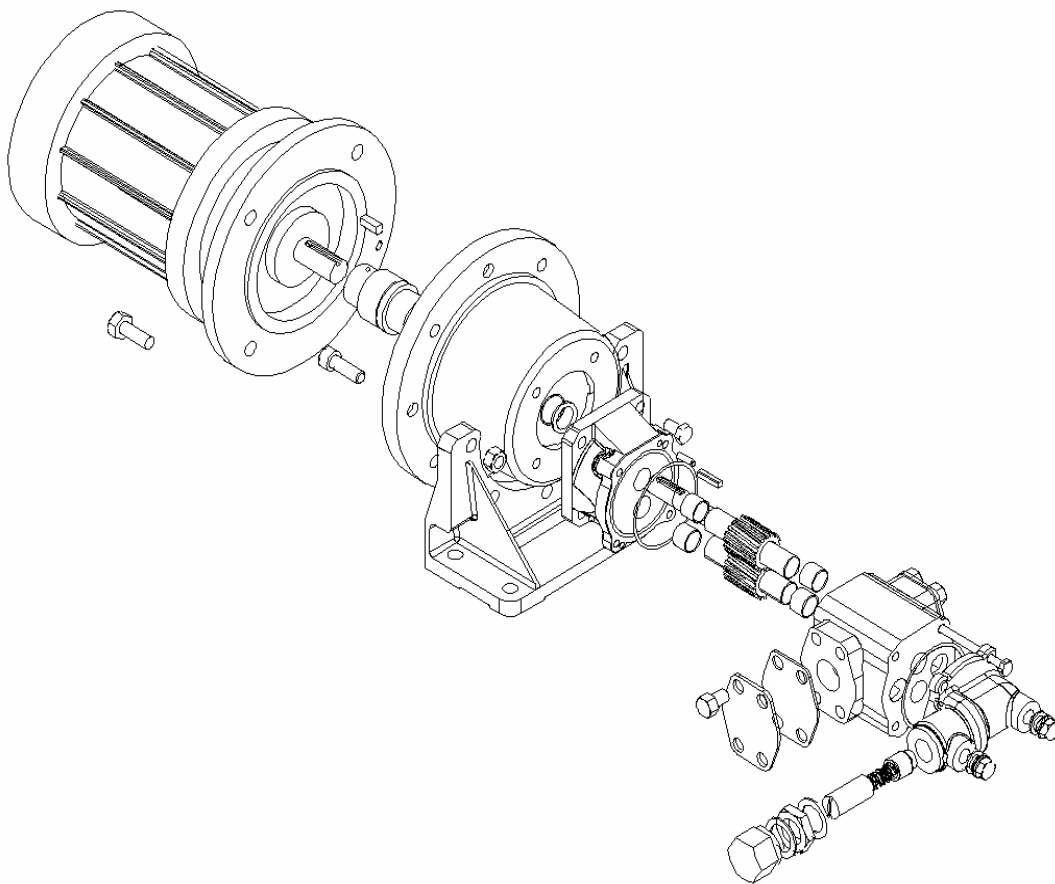
PART NUMBER	IN PORT	OUT PORT	O-RINGS	OVERHAUL KIT
RLVA-25683-001-1	1 ¼"	1 ¼"	Buna-N	2-26119-001
RLVA-25683-001-2	1 ¼"	1 ¼"	Viton	2-26119-002
RLVA-25683-001-1-01	1 ½"	1 ½"	Buna-N	2-26119-001
RLVA-25683-001-2-01	1 ½"	1 ½"	Viton	2-26119-002

KEY NO.	DESCRIPTION	PART NUMBER
1	Housing, Relay Valve (1 ¼" NPT)	2-25764
1	Housing, Relay Valve (1 ½" NPT)	2-25764-001
2	O-Ring, Buna - N	9-90001-221
2	O-Ring, Viton	9-90002-221
3	O-Ring, Buna - N	9-90031-324
3	O-Ring, Viton	9-90030-324
4	Piston	2-25694
5	Dampener, Shock	2-25107
6	Cap, O-Ring	2-25106
7	Spring, Compression	9-90435
8	O-Ring, Buna - N	9-90001-218
8	O-Ring, Viton	9-90002-218
9	End Cap	2-25693
10	O-Ring, Buna - N	9-90001-035
10	O-Ring, Viton	9-90002-035
11	Ring, Retaining	9-92001-016

TDI TURBOVALVE™
FROM TECH DEVELOPMENT INC.

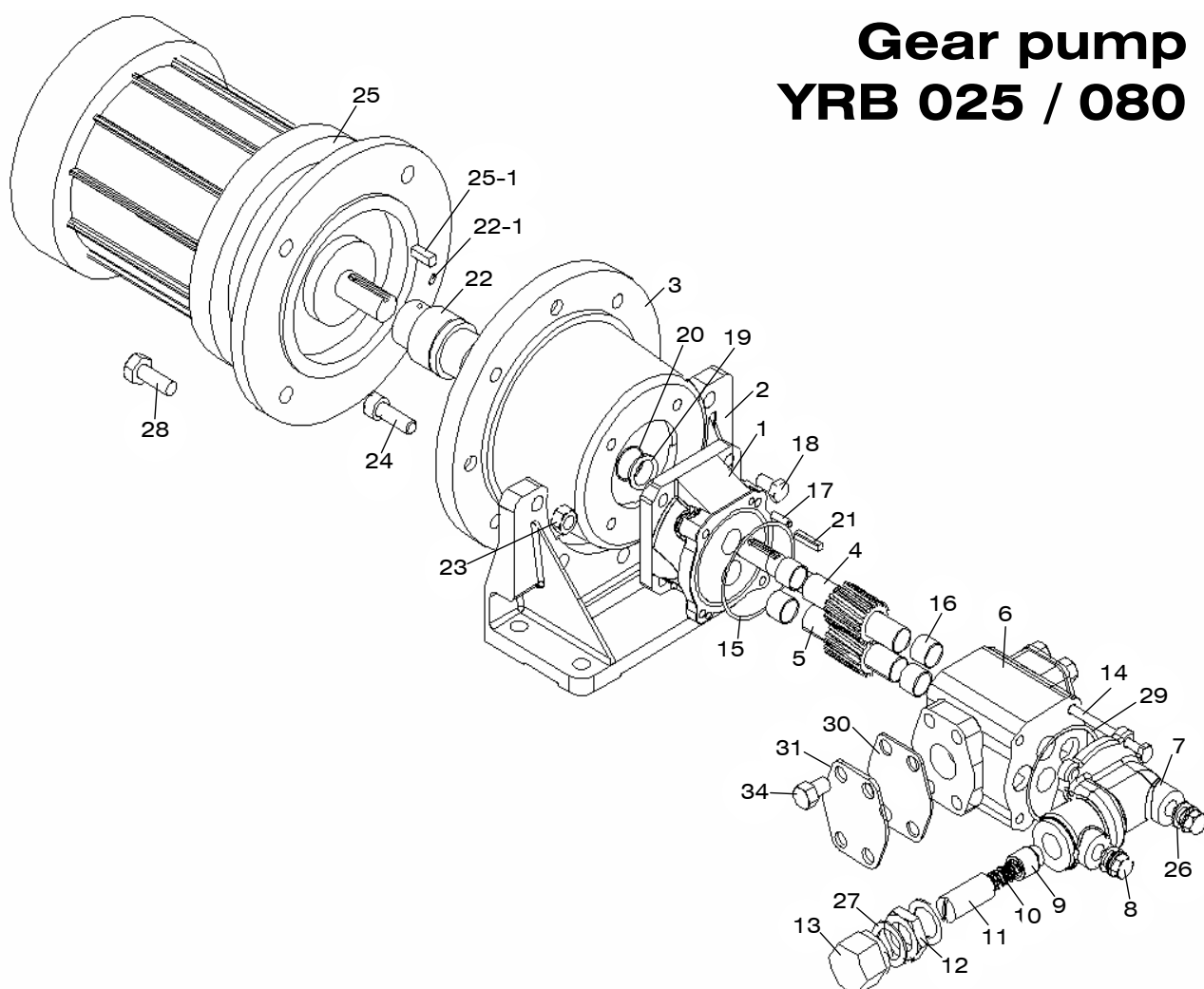


***Maintenance and Service
Instruction***



Exploded view

Gear pump YRB 025 / 080



List of components

POS. NO	Denomination	Q'TY	YRB025	YRB080	POS. NO	Denomination	Q'TY	YRB025	YRB080
01	DRIVING COVER	1			20	SNAP RING	1	R28(HOLE)	R32(HOLE)
02	BRACKET	1			21	KEY	1	5 X 5 X 25	6 X 6 X 32
03	CONNECTION COVER	1			22	JAW COUPLING	1	Ø15 X Ø19	Ø20 X Ø28
04	DRIVING GEAR SHAFT	1	M2.116X12	M3.175 X 11	22-1	SET SCREW	2	M5	M6
05	GEAR SHAFT	1	M2.116X12	M3.175 X 11	23	NUT	3	M10	M12
06	GEAR HOUSING	1			24	SOCKET HEAD BOLT	3	M10 X 30	M12 X 35
07	VALVE HOUSING	1			25	MOTOR	1	0.85kW	3.6kW
08	PLUG	2	PF1/4	PF1/4	25-1	KEY	1	6X6X30	7 X 8 X 35
09	PISTON	1			26	WASHER	2	Ø18XØ13X1	Ø18XØ13X1
10	COMPRESSION SPRING	1			27	WASHER	2	Ø32XØ21X1	Ø32XØ23X1
11	SPRING HOUSING	1			28	HEX'S HEAD BOLT	4	M10 X 30	M12 X 30
12	STOP NUT	1	PF 1/2	PF5/8	29	O-RING	1	G65 x 2t	G75 x 3.1t
13	CAP NUT	1	PF 1/2	PF5/8	30	RUBBER PLATE	2		
14	HEX'S HEAD BOLT	4	M6 X100	M10 X105	31	COVER PLATE	2		
15	O-RING	1	G65 X 2t	G75 X 3.1t	32	NAME PLATE	1		
16	BUSH	4	DU1625	DU2230	33	RIVETS	4	Ø2 X 10	Ø2 X 10
17	PIN	2	Ø5 X 15	Ø6 X 15	34	HEX'S HEAD BOLT	8	M10 X 15	M12 X 15
18	HEX'S HEAD BOLT	4	M8 X 15	M10 X 25					
19	OIL SEAL	1	Ø16XØ28X7	Ø32XØ22X7					

목차

INDEX

1. 설계사양

2. Gear pump 기능

3. 유지 및 보수

4. 윤활유

5. 분해 및 조립

6. 부품의 교환

7. 설 치

8. 조립도면

9. 예비부품 목록

1. Design specification

2. Function of gear pump

3. Maintenance and service

4. Lubricating oil, grease

5. Dismantling and assembling

6. Replacement of parts

7. Mount, installation

8. Assembly drawing

9. Spare parts list

1. 설계사양

1-1 전동기

TYPE	YRB025	YRB080
rpm	3,440	3,490
Voltage (V)	3X440(480)	3 X 440
Frquency(Hz)	60	60
Protection	IP55	IP55

1-2 펌프

TYPE	YRB025	YRB080
rpm	3,400	3,450
capacity (m³/h)	2.6	8.2
Max.Work press(bar)	0.5	1.4
Min.Work press(bar)	0.1	0.14

2. 기어 펌프의 기능

예비 윤활 오일펌프는 모터에 의해 구동 되는 기어 타입 펌프로 엔진 시동 30분전에 Pump를 구동시켜 엔진 내부 각 구동부에 윤활오일을 공급 하는 장치로서 엔진 초기 시동시에만 사용되는 펌프임.

3. 유지 및 보수

- 3-1 기어 오일 펌프 의 최초기동시는 펌프 내부에 오일이 충만한 상태로 운전 되어져야 하며, +23℃ ~+90℃ 까지 사용가능 하나, 오일온도가 +40℃~ +60℃에서 정상 운전 된다.
- 3-2 오일 온도가 +15℃이하에서는 반드시 가열을 해서 구동시켜야 하며 과다한 열의 발생, 이상소음이나 진동이 일어날 경우는 즉시 작동을 중지하고 원인을 조사하여 제거한 후 사용한다.

4. 윤활유

기어 오일 펌프에 사용되는 오일은 SAE#30/40을 적용하며 오일을 교체. 보충시기는 주엔진 오일교체. 보충 시기에 따른다.

5. 분해 및 조립

5-1. 분해

- 5-1-1 취급설명서에 첨부된 도면을 완전히 이해한 후 분해 할 것.
- 5-1-2 분해의 목적을 정확히 하고, 분해할 부위를 최소로 한다.
- 5-1-3 분해시 필히 각 부품의 위치를 표시하고 분해하는 순서에 따라 정리한다.
- 5-1-4 어떤 경우에도 각 부위를 무리하게 두드리지 말고, 강제적인 힘을 가해서는안된다.

1. Design specification

1-1. Electric motor

TYPE	YRB025	YRB080
rpm	3,440	3,490
Voltage (V)	3X440(480)	3 X 440
Frquency(Hz)	60	60
Protection	IP55	IP55

1-2 Pump

TYPE	YRB025	YRB080
rpm	3,400	3,450
capacity (m³/h)	2.6	8.2
Max.Work press(bar)	0.5	1.4
Min.Work press(bar)	0.1	0.14

2. Function of gear pump

Prelubricating oil pump is a kind of gear type pump which is operated by electric motor. It supply, deliver lubricating oil to each inside driving part of the engine by operating pump 30 minutes before engine start-up and used only for engine start-up.

3. Maintenance and service

- 3-1. At the initial start-up stage of gear oil pump, inside of the pump should be fully filled with oil. It is applicable in the range of +23℃~+90℃, however, it is normally operated at +40~+60℃.
- 3-2. When oil temperature is under 15℃, it should be driven after heating. And if it generates excessive heat, noise and vibration, deenergize it immediately and investigate causes, then use it again after have removed causes.

4. Lubricating oil

Oil used in gear oil pump applies to SAE#30/40. The time that change and replace oil is in accordance with main engine's.

5. Dismantling and assembling

5-1. Dismantling

- 5-1-1 Dismantle after clearly understand about drawing which is attached in guideline.
- 5-1-2 Ensure the object of dismantling and minimize parts to dismantle.
- 5-1-3 When dismantling, certainly mark the position of every part and arrange it by dismantling order.
- 5-1-4 Do not hammer or load excessive pressure on each part in any cases.

5-1-5 만약 분해작업이 어렵다면 도면을 재검토하여 구조를 충분히 이해한 후 다시 한다.

5-2 조립

5-2-1 주위 환경을 먼지등이 없도록 청결히 한다.

5-2-2 각 부품은 세척유로 철저히 세척하고, 결합 분위에는 적당한 윤활유를 바른후 조립한다.

5-2-3 분해시에 표시한 위치를 준수한다.

5-2-4 펌프조립이 완료되면 커플링연결축을 손으로 돌렸을때 부드럽게 돌아가야한다.

5-2-5 모터 와 펌프를 최종적으로 조립한다.

6. 부품의 교환

6-1 드라이빙 기어 샤프트 는 유림공업(주)에서 설계된 특수제품임으로 필요시 제작구매 요청할 것.

6-2 모터용 베어링은 표준규격품을 사용하였으므로 시중구매가 가능하다.

6-3 오일실은 고무재질로서 사용환경에 따른 고무의 열화로 성능이 저하될수 있으므로 정기적인 교체가 필요하며, 어떤 이유로 분해했을 경우에도 새것으로 교체 해야한다. 교체시에는 내.외경에 손상을 입지 않도록 특별히 주의해야됨.

7. 설 치

예비오일 펌프는 수직, 수평 설치를 원칙으로 하며 설치 볼트는 완전히 죄어 진동이나 충격등 외력에 견딜 수 있도록 한다. 부적당한 설치는 펌프의 수명을 극단적으로 줄일수 있으며, 파손등 중대한 결함을 초래할 수 도 있다.

8. 조립도면

별 첨

9. 예비품 목록

Po No	명칭	수량	TYPE	
19	오일실	1	YRB025	YRB080
			0	0

5-1-5 If you find any difficulty on dismantling work, recheck drawing and try again after understand structure completely.

5-2 Assembling

5-2-1 Ensure that there is not any dust in surrounding environment.

5-2-2 Clean every parts thoroughly with cleaning fluid and assemble it after grease connecting coupling part.

5-2-3 Marked position at dismantling stage should be observed.

5-2-4 When pump assembling is completed, coupling connection axle should turning(rounding) softly by hand.

5-2-5 Assemble motor with pump in final.

6. Replacement of parts

6-1 As driving gear shaft is a special product designed by Yurim industries, request purchase order if necessary.

6-2 Bearing for motor is standardized goods, therefore it is purchasable from market.

6-3 As oil seal is made of rubber material, its capacity might fall off by rubber deterioration that caused by working environment, so need to be replaced regularly. And it should be replaced with new one by any reasons when dismantled. When replace it, special care must be observed that inside and outside of parts are not damaged.

7. Mounting, Installation

Pre oil pump make vertical, horizontal mounting as a principle and set-up bolt should be tightened firmly to stand against vibration or impact and so on. Inappropriate installation might reduce pump's service life extremely and cause serious damage and injury.

8. Assembling drawing

attached

9. spare parts list

Po No	명칭	수량	TYPE	
19	OIL SEAL	1	YRB025	YRB080
			0	0

AMOT CONTROLS

Quality and reliability for over 40 years

Internally Sensed Valves Maintenance & Troubleshooting Guide (Model B)

Maintenance

Amot thermostatic valves require minimal maintenance. Elements in normal service are designed for many years of trouble-free operation.

Excessive temperatures, chemical, electrolytic attack or cavitation can shorten the life of the elements, seats, sleeves and seals. All of these are replaceable parts.

Water additives and synthetic based lubricants may cause swelling of O-rings to a point that valve action may be impaired. Distorted O-rings should be replaced. Should this occur, contact the factory for alternative materials

Carbonates, limescale and other solids must not be permitted to build up on sliding valves or element cup surfaces. The valve and elements may be cleaned with mild acid solutions. Hard scale may require wire brushing. Unless definite problems are detected during operation, valves usually do not require inspection more than every 12 to 24 months.

Dismantling

To dismantle the valve, the following procedure should be followed:-

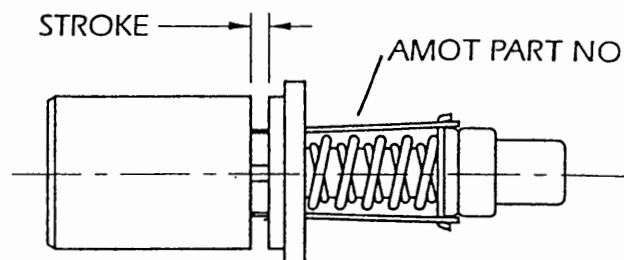
- 1 Mark valve port connections to ensure correct replacement and remove from system.
- 2 Remove valve cover or split housings (depending on valve type.)
- 3 All internals are then accessible and can easily be removed and inspected with no special tools required.
- 4 Inspect all parts and replace those with any indication of wear or damage.
- 5 Any spares required are readily available from Amot. When ordering spare parts, specify valve part number, serial number and nominal temperature. If unsure, all elements are stamped with Amot part number and nominal temperature (in degrees Fahrenheit).
- 6 When re-assembling any valves, it is recommended that O-rings are lightly greased prior to fitting to ease assembly.
- 7 Some valves with manual override fitted require the removal of a roll pin before element can be removed.

Checking Element Operation

Amot elements can be checked for correct operation as follows:-

- 1 Note element part number stamped on element, last three numbers denote nominal temperature in degrees Fahrenheit.

- 2 Heat a suitable volume of water with the element cartridge fully immersed. Agitate water to ensure even heat distribution.
- 3 Monitor the temperature as it increases; when 5°C below the nominal, the element should start to stroke.
- 4 At 5°C above, it should be fully stroked. In the case of element assemblies having sliding valves, full stroke should be approximately 8mm.



Trouble-Shooting

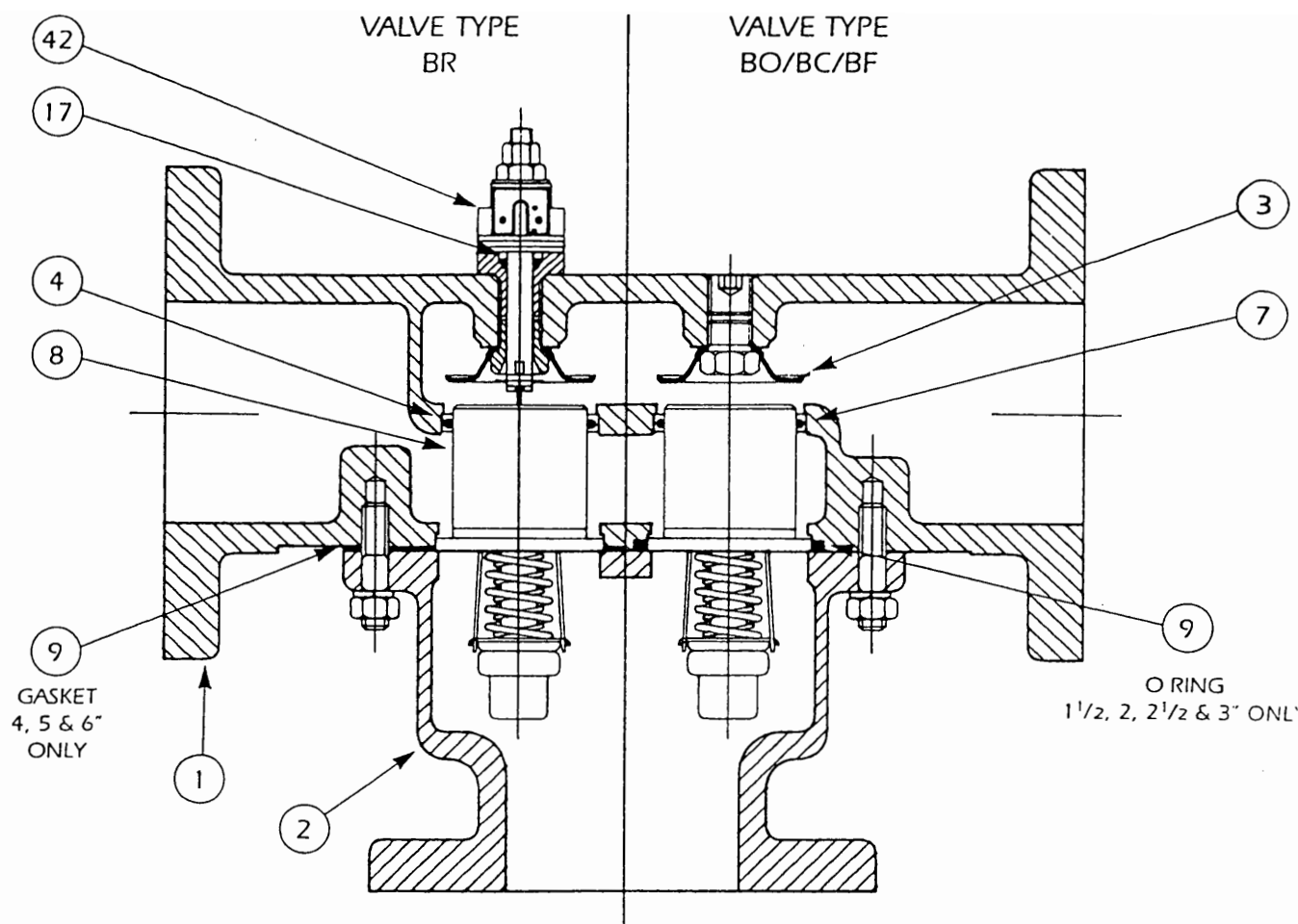
In the event that the cooling system does not operate close to the desired temperature, the following guide may help to identify or locate the problem.

System temperature too cold

- 1 Insufficient heat rejected to coolant to maintain temperature.
- 2 Wrong nominal element temperature selected.
- 3 Thermostatic valve greatly oversized or cooling capacity of system much greater than required.
- 4 Thermostatic valve installed backwards, thus sending water to cooler at low temperatures.
- 5 Worn or leaking O-rings allowing leakage to cooler.
- 6 Excessive pressure drops across the valve.
- 7 Foreign matter preventing closure of elements.
- 8 Bi-metallic type thermometers will indicate low if calibrated in oil.

System temperature too hot

- 1 Cooling capacity of system inadequate.
- 2 Thermostatic valve too small for flow rate causing high pressure drops and possible cavitation problems.
- 3 Valve installed backwards, reducing flow to cooler as temperature increases.
- 4 By-pass will not close due to worn or pitted seats, sliding valve, seals, etc.
- 5 Elements may have seen sufficient over-temperature to prevent full movement, thus preventing full cooling.
- 6 Solids building up on element sliding valve preventing correct operation.
- 7 Foreign matter stuck between sliding valve and seat.



Service Kits

Several spares kits are available; these include all seals and gaskets required to service the unit. Refer to Table A for part number and number of elements per valve size. Standard kits are for nitrile (buna N) seals – for viton or neoprene, consult factory. Kits only include Item Numbers 7, 9 and 17.

Note: Kits do not include element assemblies, seats or sleeves (Items 3, 4 and 8) – for these, refer to **Table B**, noting one of each is required per element position. Refer to **Table A** for number of elements if unsure.

Manual operator components are not available individually, but a service kit is available. The kit can also be used to convert valve type BO to BR. Please contact factory for details.

Table A SERVICE KITS

Valve Size inches (mm)	Valve Types		No. of Elements
	BO, BC, BF, BH	BR, BM	
1 1/2B (40)	46342X151	46342X154	1
2B (50)	46342X201	46342X204	1
2 1/2B (65)	46342X251	46342X254	2
3B (80)	46342X301	46342X304	2
3 3/8 (80)	46342X351	46342X354	3
4B (100)	46342X401	46342X404	4
5B (125)	46342X501	46342X504	6
6B (150)	46342X601	46342X604	9

Table B REPLACEMENT WEAR PARTS

Item	Description	Freshwater/Lub Oil	Salt Water
3	Seat	9585L001	9585L001
4	Sleeve	1182	1182P
8	Element BR & BM	2433X (Temp)	6938S (Temp)
8	Element [BO,BC,BF,BH]	1096X (Temp)	6836S (Temp)

This sheet is distributed for information purposes only. It is not to be construed as becoming part of any contractual or warranty obligations of Amot Controls Limited, unless expressly so stated in a sales contract. Amot Controls Limited reserves the right to make product design changes at any time without notice.

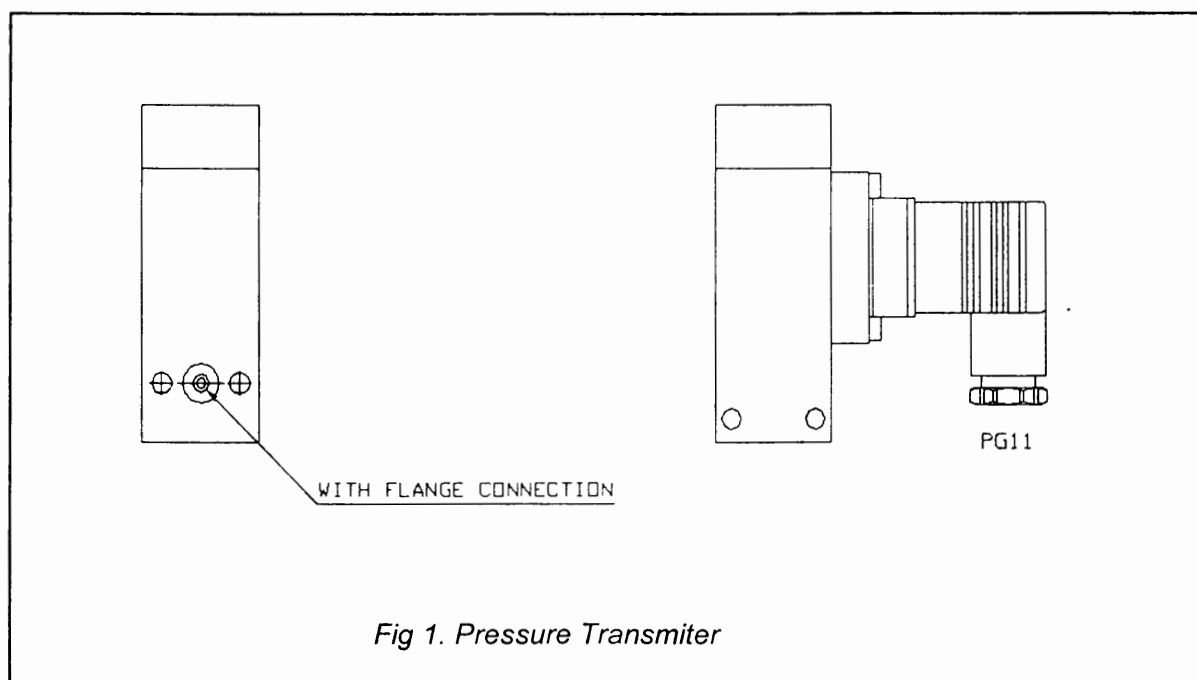
AMOT Controls Limited
Western Way, Bury St Edmunds
Suffolk IP33 3SZ
England
Telephone: (01284) 762222
Telex: 81283
Telefax: (01284) 760256

AMOT Controls Corporation
401 First Street
Richmond, California
94801-2906, USA
Telephone: (510) 236-8300
Telefax: (510) 234-9950

AMOT Controls
230 Orchard Road
#09-230 Faber House
Singapore 238854
Telephone: (65) 235 8187
Telefax: (65) 235 8869



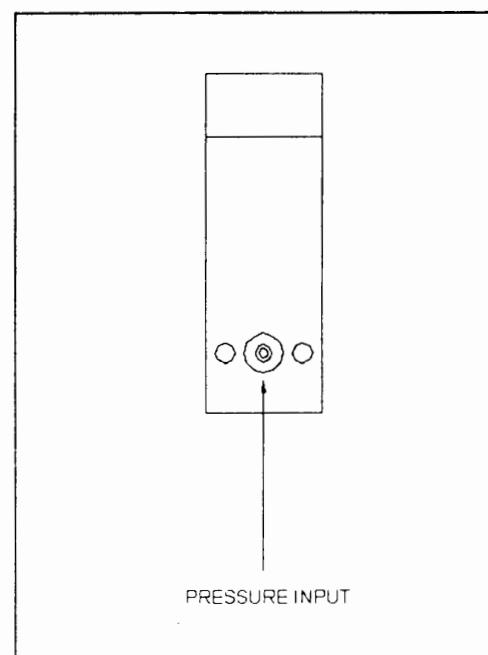
The pressure transmitter measures the actual pressure and converts the pressure to an electrical signal. This pressure transmitter is used for measuring the pressure of Compressed Air Inlet, Charge Air, HT & LT water, Fuel oil, Lub oil. See **Fig 1**.



Test

The functional test of the pressure transmitter is carried out according to the following procedure :

- 1) Shut of system pressure.
- 2) Take the sensor out of the engine.
- 3) Connect the testing apparatus to the pressure input part and input the pressure within the working area of the transmitter. **Fig 2**.
- 4) Read the pressure at the Engine Control Panel.
And, check it according to the pressure on the testing apparatus.
- 5) Remove the testing apparatus.
- 6) Connect the sensor to the Engine system.



ADJUSTMENT

The pressure transmitter has been factory calibrated, no further adjustment is normally required.

In case of adjustment, it is carried out according to the following procedure :

- 1) Remove the screw and the cap, see **Fig 3**.
- 2) Adjust the "span" screw, see **Fig 4**, to change the value of the electrical signal according to the pressure measurement area.
- 3) Be careful not to insert Driver before remove the screw and the cap, see **Fig 5**.

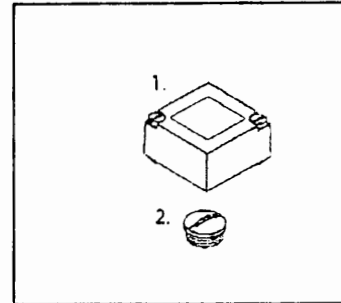


Fig 3. Remove screw and cap

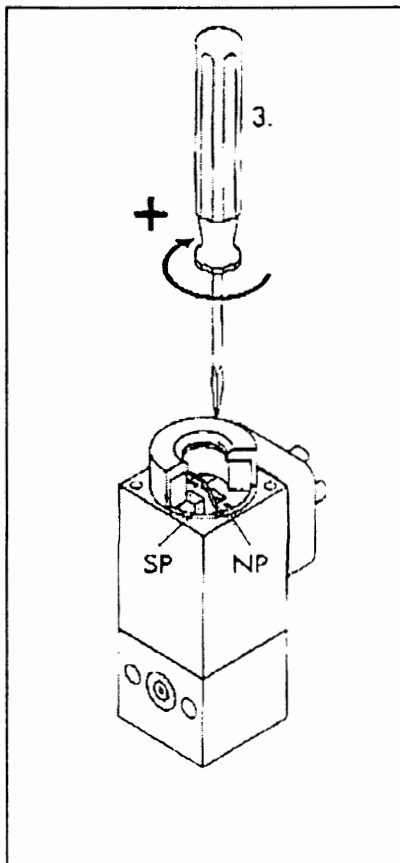


Fig 4. Adjustment of zero and span

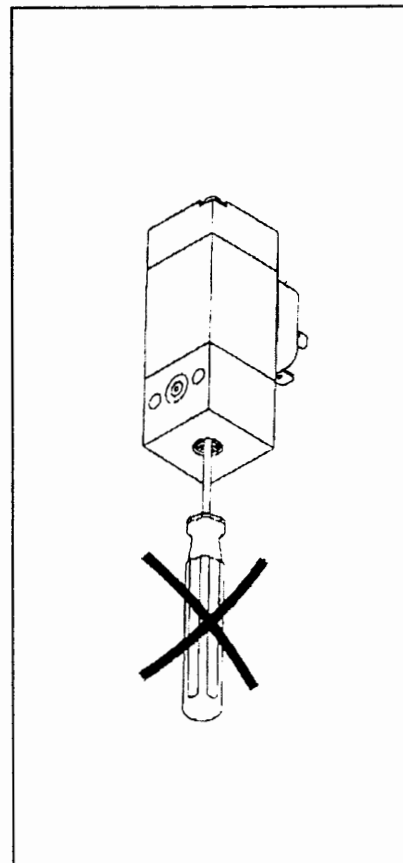
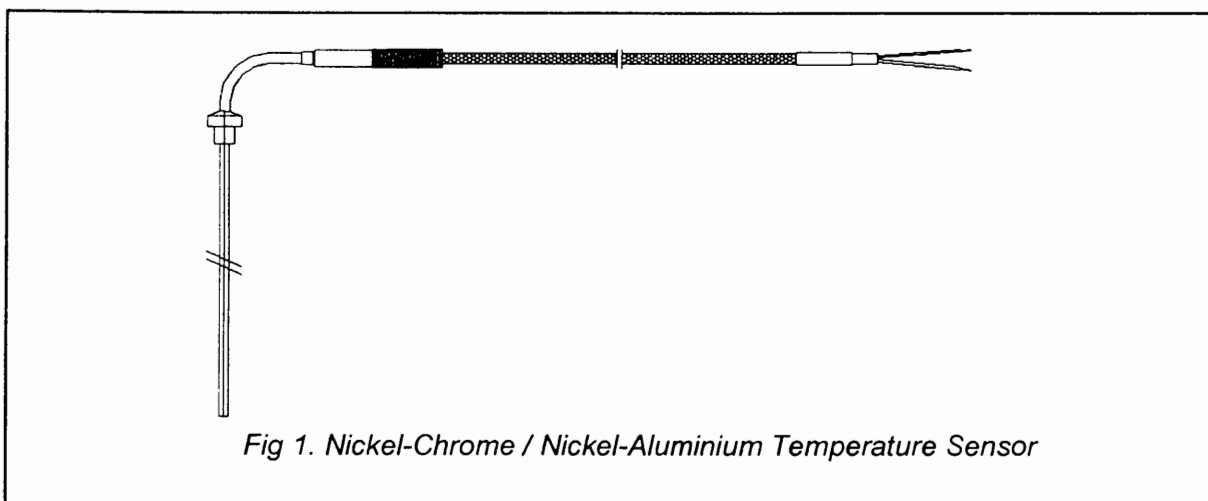


Fig 5. Attention

Three types of Temperature Transmitter is applied for this project. NiCr/Ni Sensor, Combi-Type Sensor, PT 100 sensor.

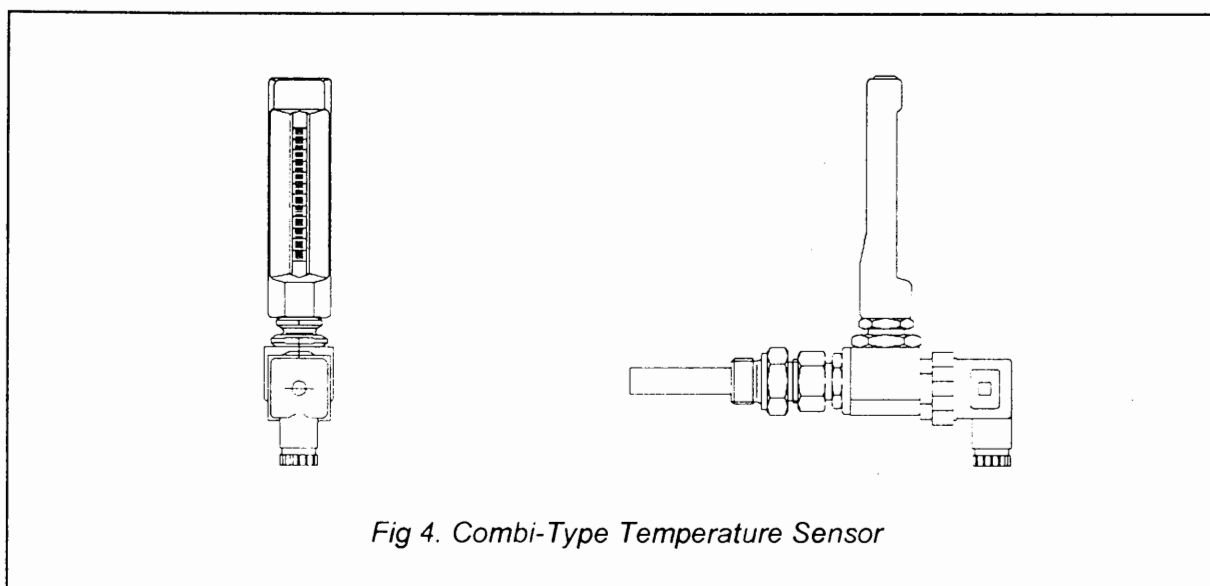
NiCr/Ni type Temperature Transmitter

The Nickel-Chrome/Nickel-Aluminium(NiCr/NiAl) sensor, which is used for measurement of the exhaust gas temperature and generates the mV signal depending on the temperature. See **Fig. 1**



Combi-Type Temperature Sensor

The Combi-Temp Type Thermometer is used for measuring the temperature of HT Water & Fuel Oil. This type of Thermometer measures the temperature and indicates the each level of temperature and generates the mV signal at the same time. See **Fig 2**.



PT100 Temperature Sensor

The PT 100 sensor consists of a resistance wire which changes resistance depending on the temperature.

The PT 100 sensor is used for measuring the temperature of Charge Air, LT water and Fuel Oil, Lub. Oil. See **Fig 3**.

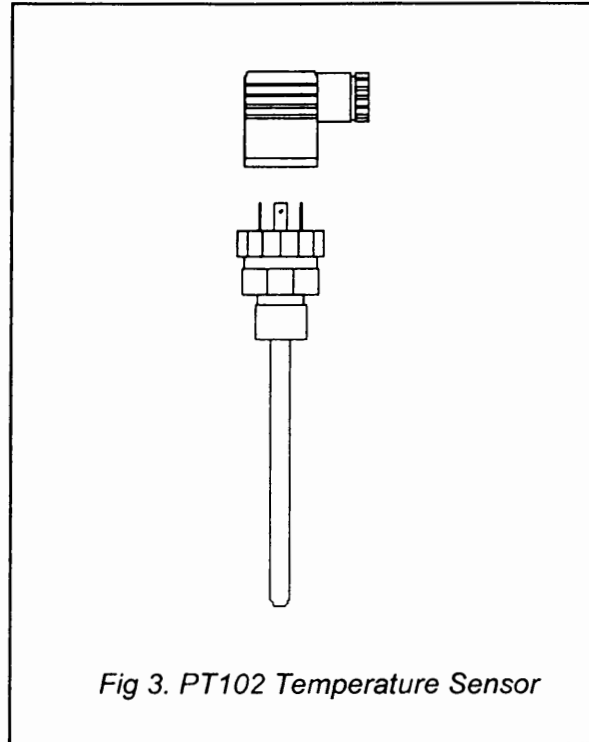


Fig 3. PT102 Temperature Sensor

Test

Functional test of the NiCr/NiAl sensor, Combi-type Sensor, PT 100 sensor can be carried out according to the following procedure.

- 1) Take the sensor out of the engine.
- 2) Test the measuring value by submerging the sensor in the water bath, which is controlled by a special testing apparatus producing a constant temperature.
- 3) Check that the measuring value indicated on the Engine Control Panel is equal to the testing apparatus measuring value.
- 4) After the above test, the sensor is mounted again.

※ NOTE

The test can also be made by special simulation instruments for the temperature sensors.

The instruments can measure the sensor value and simulate a sensor signal for the Base Module and alarm system.

Adjustment

Since these types of sensor has been factory calibrated and factory adjusted, more adjustment does not need in site. In case of sensor adjustment, the special tool and equipment needs for adjustment.

Damper



COUPLINGS AND DAMPERS. BUILT TO LAST.

GEISLINGER

ATTENTION !

PRIOR TO UNPACK the product
READ this **INSTRUCTION HANDBOOK !**

OBEY ALL INSTRUCTIONS STRICTLY
as stated in the manual !

Added drawings

Assembly

G1 05805

Parts list

..,

INSTRUCTION HANDBOOK

N° : 4001,9009..EN

Type

D 63/66

CONTENT

1. APPLICATION OF THE GEISLINGER DAMPER	3
2. SAFETY INSTRUCTIONS	4
3. TRANSPORT AND LIFTING INSTRUCTIONS	5
3.1. Transport instructions	5
3.2. Lifting appliances	5
3.2.1. High-strength lifting appliances	5
3.2.2. Eye bolts according to DIN 580	5
3.3. Tapped holes for lifting purposes	6
3.3.1. Usage of tapped holes for general purposes	6
3.4. Lifting instructions	6
4. PACKAGING AND STORAGE	7
4.1. Original packaging	7
4.2. Storage instructions	7
5. PRODUCT DESCRIPTION	8
6. UNPACKING	9
7. DAMPER MOUNTING INSTRUCTIONS	10
7.1. Preparations prior to assembly	10
7.2. Installation	10
8. INITIATION	11
9. DAMPER DISMOUNTING	12
10. DISASSEMBLY OF THE DAMPER	13
11. ASSEMBLY OF THE DAMPER	14
11.1. Preparations prior to assembly	14
11.2. Assembly	14
12. INSPECTION	16
12.1. Oil quality / engine oil change	16
12.2. Total inspection of the damper	16

13. PERMISSIBLE WEAR OF THE DAMPER ITEMS	17
13.1. O-ring item 850	17
13.2. Inner star groove - inner ends of the spring blades	17
14. TROUBLESHOOTING	19
15. OPERATING CONDITIONS	20
15.1. General remarks	20
15.2. Required oil pressure	20
15.3. Maximum permissible oil pressure	20
15.4. Oil flow rate	20
15.5. Oil temperature and viscosity	20
15.6. Permissible ambient temperature	20
16. ORDERING SPARE PARTS	21
17. APPENDIX	22

1. APPLICATION OF THE GEISLINGER DAMPER

The product in question is a Geislinger torsional vibration damper

It is specially designed and keyed to suit the designated machinery only.

Inproper or faulty installation may cause a reduction of the expectable life time of the product.

ATTENTION !

The installation of the damper in other machinery as the designated machinery can cause damage to the machinery and the damper.

2. SAFETY INSTRUCTIONS

Execute all kinds of work at or around the product only

- with skilled personnel
- at standstill of the machinery
- under adherence to the valid instructions for
 - safety regulations
 - accident prevention

The product is to be lifted and handled only by persons

- having the required licence
 - to work with cranes
 - to drive industrial trucks
- knowing the additional transport and lifting instructions
 - according to the instruction handbook
 - and the assembly drawing

3. TRANSPORT AND LIFTING INSTRUCTIONS

3.1. Transport instructions

- Move the product horizontally only
- Do not tilt the case or pallet
- Avoid hard shocks at transport
- Lifting speed is max. 50 m/min
- Do not damage packaging and protection

3.2. Lifting appliances

3.2.1. High-strength lifting appliances

They are

- delivered with the product
- painted red
- capable of being loaded in all directions
- to be used according to the instructions
 - on the assembly drawing
 - or the lifting sketch.

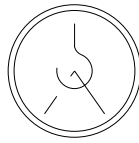
3.2.2. Eye bolts according to DIN 580

They are

- **not** included in the delivery
- **not** loadable lateral to the ring plane
- to be used according to the instructions
 - of DIN 580on the assembly drawing or the lifting sketch

3.3. Tapped holes for lifting purposes

These are indicated with



on the assembly drawing

Attention ! Use such marked threads only !

3.3.1. Usage of tapped holes for general purposes

- Remove bolts
- Mount the lifting appliances and lift coupling
- Dismount the lifting appliances and mount the bolts under adherence to
 - the tightening torques
 - the tightness instructions
 - and the safety instructions according to the assembly drawing

3.4. Lifting instructions

Lift the product only

- with the provided lifting appliances (see chapt. 3.2)
- with adequate and approved lifting devices of other kind (cables, chains, carrying straps) if necessary
- after mounting the lifting appliances in accordance with the regulations
- at the declared tapped holes shown on the assembly drawing (see chapt. 3.3)
- always at two points at the same time (if not otherwise stated)
- with the best possible equal load distribution

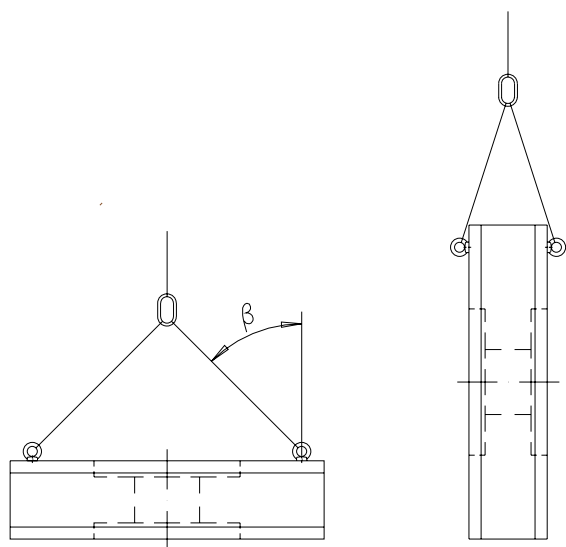
Lifting sketch

$\beta = \max. 60^\circ$

Conditions for special lifting appliances see assembly drawing !

Attention !

Do not lift the product with one lifting appliance only !



4. PACKAGING AND STORAGE

4.1. Original packaging

All metal parts are

- inhibited against corrosion
- wrapped in a rust inhibiting paper
- sealed in a polyethylene sheet
- All parts are packed in soft wooden cases

Disposal of packaging

The packaging can be recycled.

4.2. Storage instructions

- Do not damage packaging or protection
- Do not stack or place heavy objects on the product
- Store product dry; The max. permissible relative humidity is 85%
- Avoid more than 25° Celsius variation in temperature

Attention !

If the packaging of the parts is damaged or the parts are unpacked, the parts must be

- either fitted into the installation within the next 100 hours
- or repacked

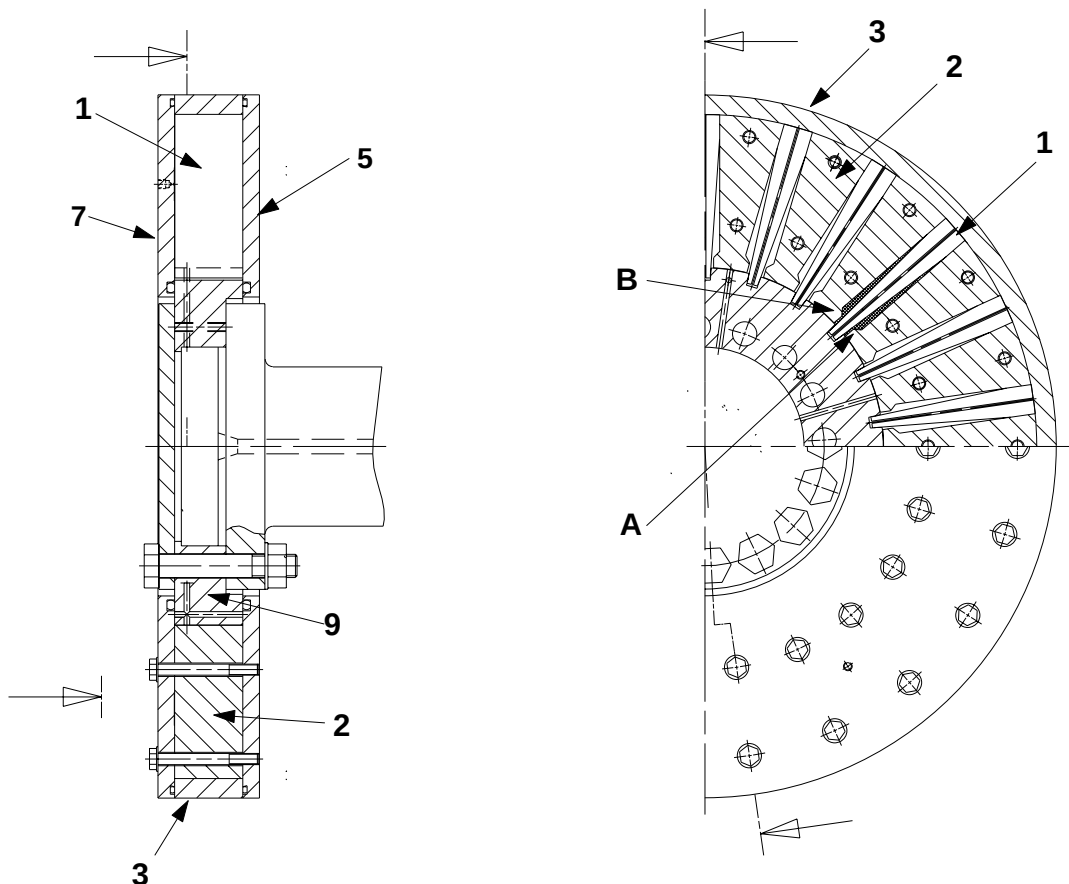
5. PRODUCT DESCRIPTION

The Geislinger damper is a spring coupled torsional vibration damper with an internal hydraulic damping system

Radial arranged leaf springs (1) transmit the elastic torque from the damper inner member to the damper outer member. The torsional vibrations are damped concurrently by oil displacement from one chamber (A,B) into the adjoining one.

The leaf springs (item 1) are clamped at their outer ends between the intermediate pieces (item 2) due to a press fitted clamping ring (item 3). The inner ends of the spring packs (item 1) reach into axial grooves of the inner star (item 9) such engaging the inner and outer member of the coupling. The chambers A and B which are formed by the intermediate pieces (item 2) and the spring packs (item 1) are filled with oil. If a torque twists the outer and inner member against each other the spring packs will be deflected. This changes the volume of the oil chambers (A,B) and the oil will be displaced from one chamber into the adjoining one through narrow gaps. The oil flow resistance retards the relative movements of the two coupling members and dampens the vibration amplitudes.

Both plates (5,7) of the damper outer member and the sealings inserted therein hold the oil so that the oil pressure which is to be used can build-up.



6. UNPACKING

- Remove damper from the packing case
- Remove polyethylene sheet and rust inhibiting paper from damper

NOTE !

Loose parts which are enclosed in the package must not be thrown away with the packing material (e.g. bolts, lifting appliances, sealings etc...)

7. DAMPER MOUNTING INSTRUCTIONS

7.1. Preparations prior to assembly

- Check the damper for possible transport damage.
- Mount the lifting appliances (730) acc. to the lifting appliance mounting instructions. Clean the surfaces underneath prior to mounting
- Bring the damper into a vertical position first (damper centre line is horizontal)
- Remove the rust inhibitor from all joint faces i.e. centring shoulders/recesses.

ATTENTION ! Do not damage or injure the parts during cleaning !

- Clean all oil supply and oil return holes of the damper and the crankshaft. Remove adhesive tape or any other objects if existing.
- Oil carefully the sealing surfaces of the crankshaft O-rings with engine oil (class 15W40)

7.2. Installation

- Mount the damper as shown on the assembly drawing.

ATTENTION ! Do not damage or injure the centring shoulders and sealing surfaces during mounting !

8. INITIATION

Check before first trial run

Use the pre-lubrication pump to supply the damper with pressure oil until oil escapes from the venting holes. For position and number of venting holes see assembly drawing.

ATTENTION !

If no oil escapes from one or more venting holes, execute the instructions as stated in chapter 13.2.

Most dampers have tapped holes on flange or lateral plate to mount a pressure gauge onto the damper. There the oil pressure can be measured at the standstill of the engine.

9. DAMPER DISMOUNTING

- Withdraw the crankshaft bolts (do not remove them)
- Mount the lifting appliances (730) onto the damper and suspend the damper on the crane.
- Remove the crankshaft bolts
- Insert forcing bolts into the damper inner star (9) and push back the damper from the crankshaft flange slowly and evenly

ATTENTION ! Do not damage or injure the centring shoulders and sealing surfaces during dismounting !

- Rest damper onto lateral plate (5). (damper centre line vertical)

10. DISASSEMBLY OF THE DAMPER

ATTENTION !

Open damper main bolts (750) only if it is required (e.g. for a total spring inspection)

The concentricity setting of the damper outer member will be lost, if no centring shoulders exist between the spring assembly (1,2,3) and lateral plates (5, 7)

- Rest damper onto lateral plate (5). (damper centre line vertical)
- Remove damper main bolts (750)
- Remove lateral plate (7)
- Remove spring assembly (1, 2, 3)
- Remove inner star (9)

Now a complete inspection of the damper can be carried out.

ATTENTION !

The exchange of damaged or worn spring packs(1) requires dismounting and refitting of the clamping ring (3). Such work is to be carried out only at the manufacturer's works or by a Geislinger service specialist

11. ASSEMBLY OF THE DAMPER

11.1. Preparations prior to assembly

- Clean every single part carefully.

ATTENTION !

All oil supply and venting holes must be clean and free of dirt

- Exchange all seals (O-rings...)
- Exchange all disc springs (810) of the coupling main bolts (750)
- Grease carefully all O-rings (850 ,851) and the appropriate grooves with Klüber PETAMO GHY 133N or equivalent
- Insert O-rings (850 and 851) into the appropriate grooves in flange (5) and side plate (7)
- Coat inner-star (9) running surface of O-ring (850) carefully with Klüber PETAMO GHY 133N paste or equivalent
- Coat rest of inner-star (9) with ANTICORIT OHK 380A or equivalent
- Apply MOLYKOTE 1000 paste or equivalent to the threads of the damper main bolts (750)

11.2. Assembly

- Place flange plate (5) onto the centring table (O-rings are visible)
- Place spring assembly (1, 2, 3) onto the flange plate (5)
- Insert inner-star (9)
- Place lateral plate (7) onto spring assembly (1, 2, 3)
- Centre flange plate (5), spring assembly (1, 2, 3) and lateral plate (7) according to the permissible concentricity values as stated on the assembly drawing.

NOTE !

An excess of 30% of the stated circularity value is still permissible, if no unbalance problems arise from that.

- Apply enough LOCTITE (type see assembly drwg.) onto both sides of the disk spring (810)

ATTENTION !

The disk springs (810) and the appropriate seat-engaging surfaces must be dry and free of grease (oil)

- Mount the damper main bolts (750) according to the mounting instructions as stated on the assembly drawing

- Check the concentricity settings as stated on the assembly drawing again

ATTENTION !

An excess of 30% of the stated circularity value is still permissible, if no unbalance problems arise from that. Exceeding this limit requires remounting and correction to obtain better values.

Remove damper main bolts (750)

- Exchange disc springs (810) and clean the appropriate seat-engaging surfaces. All seat-engaging surfaces must be dry and free of grease (oil)
- Apply enough LOCTITE (type see assembly drwg.) onto both sides of the disk springs (810) and mount the damper main bolts (750)
- Check the concentricity settings as stated on the assembly drawing again. (Repeat the assembly of the damper outer member again if the permissible concentricity values are exceeded.

12. INSPECTION

12.1. Oil quality / engine oil change

Check the oil quality at regular intervals.

Bad oil quality or a water mix - especially seawater - with the engine oil can cause damage to the damper. That reduces the life time of the damper rapidly.

Carry out the required activities according to chapter 14 if bad oil quality is present or an oil change is to be carried out.

12.2. Total inspection of the damper

Carry out a total inspection according to the

- given inspection intervals
- and the inspection instructions

INSPECTION INTERVALS AND INSTRUCTIONS Inspection intervals in service hours based on normal service conditions	
28.000 – 30.000 <u>kind of inspection</u> dismount damper separate damper inner member from damper outer member (do not disassemble damper spring assembly) clean all parts, especially oil supply.- and venting holes replace all accessible rubber seal rings replace all disc springs and lock washers of the dismantled bolts check the permissible wear according to chapter 13 parts which are exposed to wear may have to be refurbished or exchanged if required	40.000 – 60.000 <u>kind of inspection</u> carry out a 30.000 service hours inspection carry out additionally : disassemble damper outer member service or replacement of spring packs (1) and inner star (9) ATTENTION ! A disassembly of the damper outer member is to be carried out by a Geislinger service station or by Geislinger
If an inspection should show that more than 50% of the wear limits have been consumed within one inspection interval only, the following inspection interval is to be reduced in time by assuming a linear wear rate	
The inspection intervals are depending on the different specific operating conditions.	

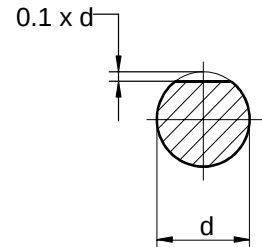
NOTE

**Regular inspection and supervision of the damper allows for advanced planning and
 the ordering of spare parts in time !**

13. PERMISSIBLE WEAR OF THE DAMPER ITEMS

13.1. O-ring item 850

- The total wear must not exceed 10 % of the rope diameter "d" (see fig.)
- The total wear is the sum of
 - the wear of the O-Ring
 - + the depth of the run-in grooves on inner star
 - + the depth of the run-in grooves on the lateral plates (5 or 7)
- O-Ring nominal diameter see parts list



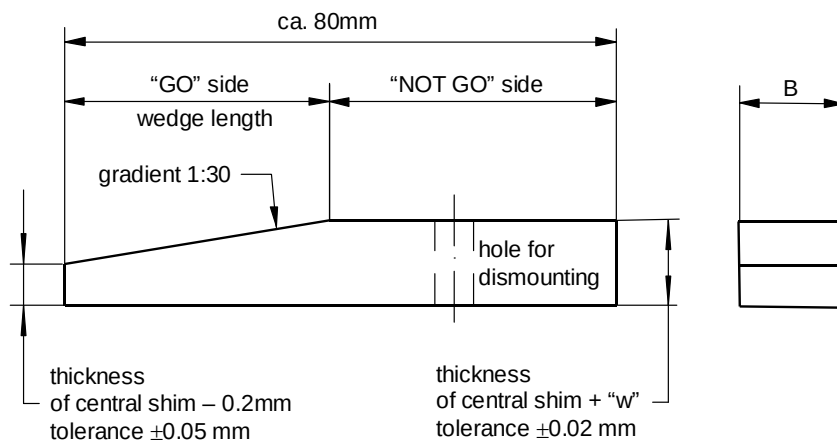
13.2. Inner star groove - inner ends of the spring blades

The total wear – inner star groove / inner ends of spring blades - must not exceed the value „w“ as stated on the assembly drawing or the appended data sheet

Testing tool

A measuring wedge is to be used as a testing tool. The measuring wedge is to be produced by the customer if no measuring wedge is supplied by Geislinger.

Use the following sketch to produce a measuring wedge.



The thickness of the central shim, the wear dimension „w“ and the width of the measuring wedge „B“ are stated on the assembly drawing or the appended data sheet.

Measuring wear

Measure approximately every fourth spring pack

Place the measuring wedge between the inner ends of the spring blades resting the wedge on the groove bottom.

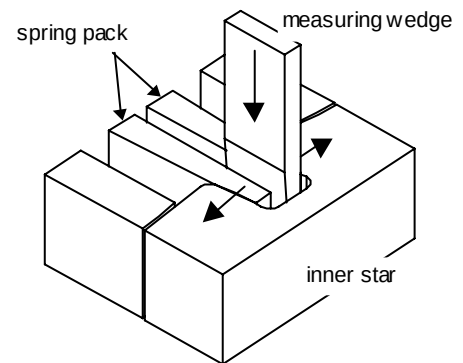
Press by hand or use a soft hammer to force the measuring wedge along the inner star groove, until the spring tips rest on both groove faces.

The further the measuring wedge can be pressed between the spring blades the greater is the wear of the inner star groove and the spring blades.

NOTE :

Half wedge length means half wear, three-quarters wedge length means three-quarters wear, and so on

Replace inner star and spring packs if the measuring wedge can be pressed between the spring blades over the total wedge length.



14. TROUBLESHOOTING

Inspected condition	Corrective measure
Pressure oil supply with the pre-lubrication pump; No oil escapes from one or more venting holes	Dismount damper; Check oil supply holes on the damper and on the crankshaft; Free oil discharge must be guaranteed
Total wear of the O-Rings (850) does not exceed the permissible value of wear	Exchange O-ring(s); Smooth and polish the run-in grooves
Total wear of the O-Rings (850) exceeds the permissible value of wear	Exchange O-ring(s) and exchange or repair worn parts. (Clarify repair with Geislinger or a Geislinger service station)
The total wear at the spring tips (engagement with inner star grooves) exceeds the permissible value "w"	Exchange inner star (9) and spring assembly (1, 2, 3)
Bad oil quality / oil change or higher water content in the engine oil as permitted Effect: no damage to the engine bearings	Remove venting screw (756) (if existing) Drain damper totally (drain hole in 6 o'clock position) Fill up damper with fresh engine oil and drain damper again; repeat flushing several times
Bad oil quality or higher water content in the engine oil as permitted Effect: damage to the engine bearings	Carry out a 28.000 – 30.000 service hours inspection according to chapter 12.2
Assemble the damper according to the mounting instructions as stated in chapter 11 (assembly of the damper)	

15. OPERATING CONDITIONS

15.1. General remarks

All specifications made in the operating instructions apply to standard applications. In case of doubt, please consult Geislinger (TVC department).

All specified values for the oil supply of the damper are valid immediately before entry of the oil into the damper. (Connection of the damper to the customer part)

WARNING!

If the following operating conditions are not specified either on the assembly drawing or in the operating instructions, please consult Geislinger.

15.2. Required oil pressure

The specified oil pressure (combined with the oil flow rate) must be regarded as the required oil pressure.

If no oil pressure (combined with the oil flow rate) is specified, then the damper must be supplied with a required oil pressure of at least 2.5 bar overpressure (3.5 bar absolute).

WARNING !

If the specified required oil pressure is not achieved, please consult Geislinger.

15.3. Maximum permissible oil pressure

The maximum permissible oil supply pressure is 6 bar absolute.

If the supply pressure is higher than specified, please consult Geislinger.

15.4. Oil flow rate

The specified oil flow rate refers to the required oil pressure.

WARNING !

If the damper is supplied with a higher oil pressure than the specified required oil pressure, then the oil flow rate increases accordingly.

15.5. Oil temperature and viscosity

The specified oil temperature and viscosity correspond to the values used in the design TVC. If no data was available to Geislinger at the time of design, then common industry values underlie the calculation. Oil temperature and viscosity are either noted on the assembly drawing or they can be requested from Geislinger.

15.6. Permissible ambient temperature

The permissible oil and ambient temperature arise from the oil viscosity which was specified when the damper was designed.

For the limit values, see the respective design calculation or request them from Geislinger (TVC department).

16. ORDERING SPARE PARTS

ATTENTION !

Use original GEISLINGER spare parts only

Supply the following information to allow an exact identification of the product

- The damper designation (→ see type plate, mounted on the damper outer member)
- Works number of the damper (→ see type plate)
- Drawing number of the parts list
- Item number of the replacement part
- Name of the replacement part
- Number of pieces required

Example

Designation	D 44/1/1
Works no.	OJY 001/98
Parts list no	G4 10033
Item number of replacement part	850
Number of replacement parts	1
Name of replacement part	O-ring 22 x 328

17. APPENDIX

This instruction hand book contains the following supplement :

- MANUFACTURERS DECLARATION
- ASSEMBLY DRAWING / PARTS LIST
- DATA SHEET „WEAR OF SPRINGS AND INNER STAR GROOVE“ (if no permissible wear of springs is stated on the assembly drawing)
- GUARANTEE
- LIST OF SERVICE STATIONS ⇒ www.geislinger.com (Geislinger homepage)

General assembly instructions for screws and screw/nut connections

These instructions are intended to supplement the assembly instruction for screws given on the assembly drawing

TABLE OF CONTENTS

1. CLEANING THE THREADED PARTS	2
2. APPLYING ASSEMBLY AIDS	4
3. ASSEMBLY	6
4. AFTER ASSEMBLY	7
5. RE-USE	8

1. CLEANING THE THREADED PARTS

Before handling the threaded parts using the assembly tools, the contact surfaces must be cleaned carefully and thoroughly.

These include the contact areas

- the screws on the head support and on the thread ► see Figure 1
- the nuts (if present) on both support surfaces and on the thread ► see Figure 2
- both sides of the washers ► see Figure 3
- the threaded holes (if present) ► see Figure 4
- and the contact surfaces on the parts being connected ► see Figure 5

Fig. 1

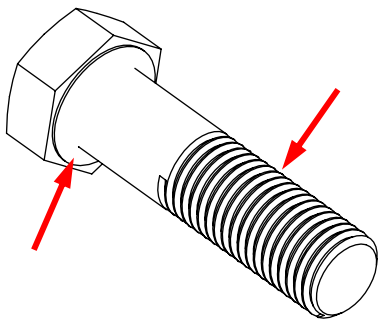


Fig. 2

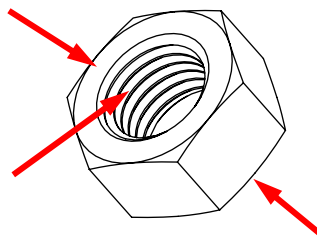


Fig. 3

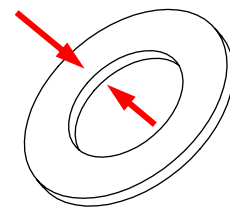


Fig. 4

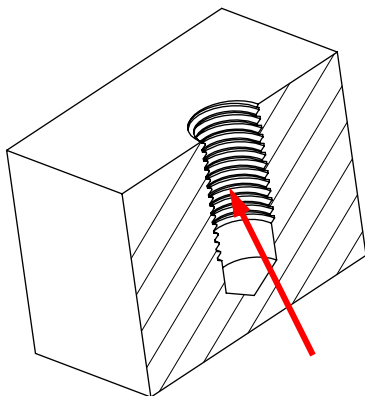
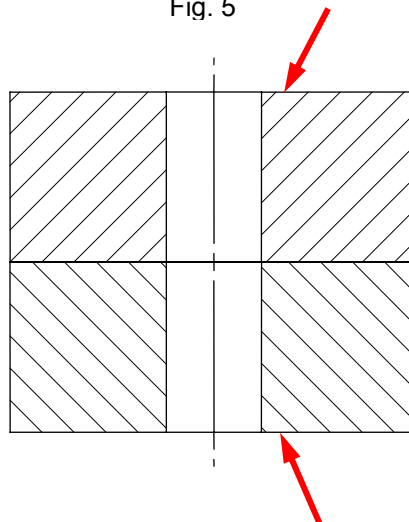


Fig. 5



Oxide layers

If the contact surfaces have oxidised, first carefully remove the oxide layers mechanically, for example using a wire brush.

Dirt and grease

After removing the oxide layers (if present), all contact surfaces must be cleaned and degreased thoroughly.

Isoparaffin or acetone can be used as agents for cleaning and degreasing.



If Loctite is used being for the assembly, degreased, cleaned contact surfaces must not afterwards be touched with bare hands.

If dirty or if coming into contact with grease from hands, the relevant contact surfaces must be cleaned **again!**

2. APPLYING ASSEMBLY AIDS

For assembly, the contact surfaces and thread must be treated with seal and/or screw securing agents or with lubricants.

Normally used as screw securing or sealants are Loctite products and engine oil or Molykote paste as lubricants.

The precise types and application of the assembly aids can be found on the relevant assembly drawings.



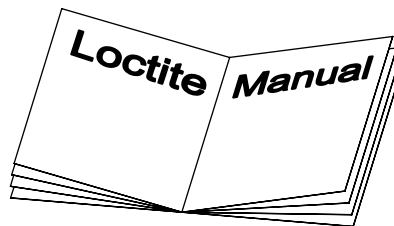
Before applying the assembly aids, the contact surfaces must be dried thoroughly!

Note on Loctite products

Loctite products should always be used within the processing time specified by Loctite.

These processing times can be found in the instructions for use for the relevant Loctite products being used. Do not exceed the maximum processing times permitted! Try and keep the processing times as short as possible.

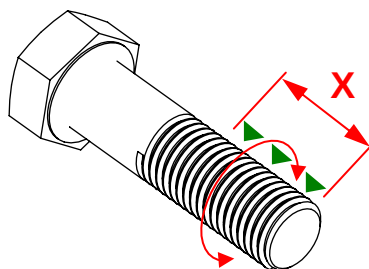
Read first!



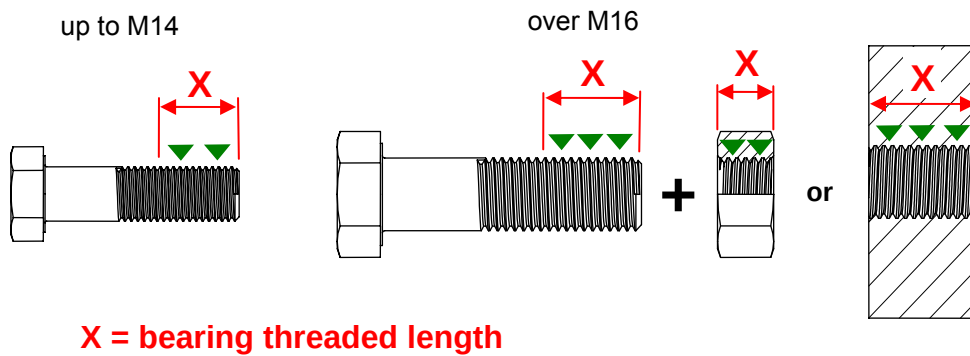
Application in threaded parts

Before applying the assembly aid, the bearing threaded length "X" (see diagram) should be calculated for the parts being screwed together. This threaded length should then be wetted with the assembly aid across the entire area. In terms of the quantity, use only so much that only small quantities of excess assembly aid overflows after assembly.

A test assembly is recommended to be able to estimate the amount required.



With sealing unions in particular, ensure that the threaded gap is completely filled with sealant. For thread size M16 and over, the threaded hole or the nut thread should also normally be coated with the assembly aid.



Application under screw heads and on washers

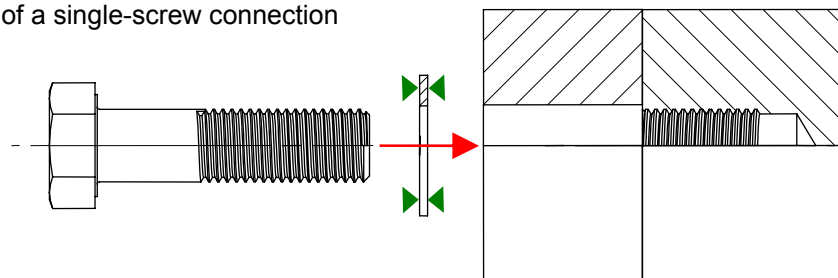
When using the assembly aids under washers or screw heads, wet the surface so that after the assembly process is complete for the screw, the contact surfaces (see diagram) is completely covered with the assembly aid.

When using on washers, apply to both the front and the back.

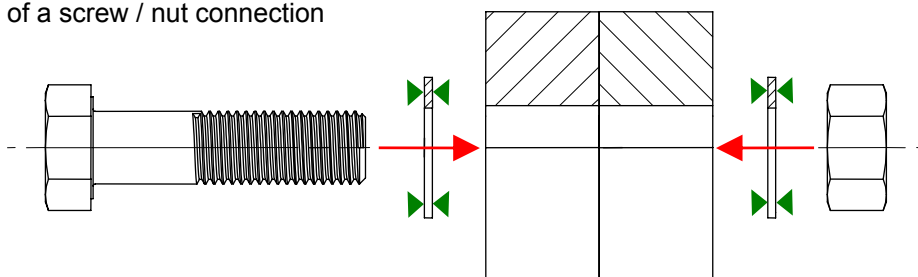
In terms of the quantity, use only so much that only small quantities of excess assembly aid overflows after assembly.

A test assembly is recommended to be able to estimate the amount required.

Example of a single-screw connection



Example of a screw / nut connection



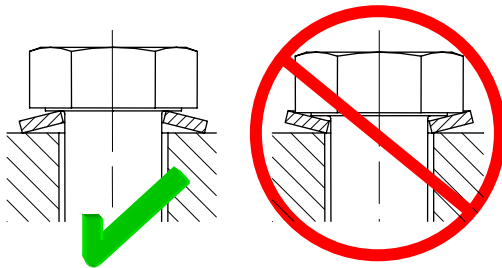
3. ASSEMBLY

The screws should only be tightened at the torques and in accordance with the guidelines given on the assembly diagram.

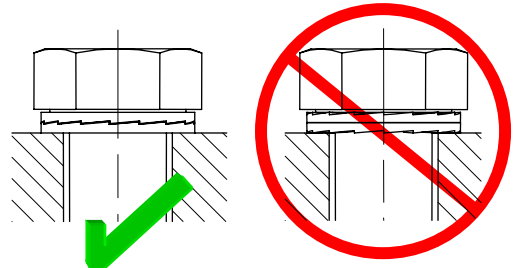
Note on washers

Spring washers and sometimes NORD-LOCK are normally only used as washers for securing screws where applicable. These should be assembled as follows.

Spring washer usage



NORD-LOCK washer usage



Tightening process

The screws should normally be tightened crosswise, i.e. opposite pairs of screws should be tightened immediately after one another.

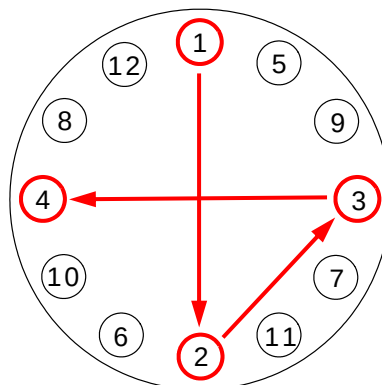
The assembly should always be carried out according to the same diagram, as described in the example below for a twelve-point division.

The torque values, the tightening of the screw and the application area for the assembly aid are described in the assembly guidelines in the assembly diagram.

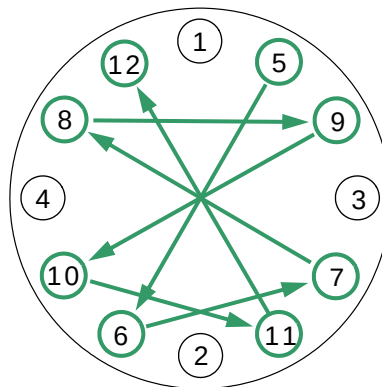
TWELVE DIVISION EXAMPLE

a) Mark screws 1 - 4

Pre-assemble screws 1 - 4 **without Loctite** assembly aid to approx. 30% of the torque value given on the assembly diagram and in the order given

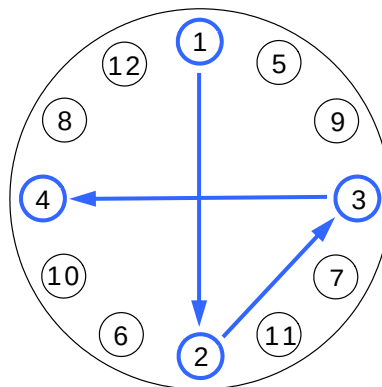


- b) Final assembly of screws 5 – 12 in the order given



- c) Remove screws 1 - 4.

Final assembly of screws 1 - 4 according to the assembly guidelines in the assembly diagram and in the order given.



4. AFTER ASSEMBLY

Immediately after the screw assembly is complete, the excess residue of the assembly aids, especially Loctite residue, should be removed

5. RE-USE

If screw connections secured or sealed using Loctite are unfastened, the any old Loctite reside remaining on the screws should be completely removed mechanically, for example using a wire brush.

With threaded connections and internal threads (e.g. with nuts), old Loctite residue should also be removed completely.



All washers from unfastened screw connections should normally be replaced by new washers!

Afterwards, all parts should be prepared for re-assembly (see chapters 1 to 4).

CONDITIONS OF GUARANTEE

The guarantee applies to defects which appear during the agreed warranty period under normal use of the coupling resp. damper and although all operation conditions have been strictly adhered to.

In particular the warranty does not apply if the installation was not built in according to the drawings by either the buyer or his representative or if the maintenance- or operating instructions were not observed or if the product was modified.

If parts or materials are used, not furnished by GEISLINGER, or which are not conform to the original specification, GEISLINGER is under no obligation of warranty.

The same applies if inadequate repair has been effectuated resp. if the repair was not done according to GEISLINGER's rule's of action and moreover if the repair was not announced to GEISLINGER in writing before starting it.

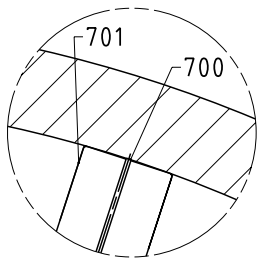
Normal wear and tear is not included in the guarantee.

During the warranty period only the buyer can bring forward claims, claims cannot be transferred to a third party.

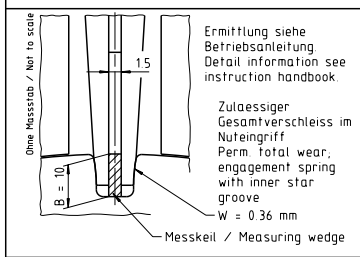
Storage until the installation goes into operation has to be in a dry place and in it's original packing material resp. casing.

Prinzipdarstellung / principle sketch

ohne Massstab / not to scale



Zulaessiger Gesamtverschleiss
Permissible total wear



EINBAUVORSCHRIFTEN / INSTALLATION INSTRUCTION

VOR EINBAU- UND INBETRIEBNAHME IST DIE BETRIEBSANLEITUNG ZU LESEN UND DEREN ANWEISUNGEN ZU BEFOLGEN !
READ AND OBEY THE INSTRUCTIONS AS STATED IN THE INSTRUCTION MANUAL BEFORE INSTALLATION AND INITIATION OF THE PRODUCT !

ENTFERNE vor dem Einbau :
- Saemtliche Klebbaender bei Oelzufuehrungen
- Saemtliche Transportabdeckungen
- Rostschutz von Anflanschlaechen und Zentrierungen. Diese Flaechen muessen fettfrei und trocken sein!

REMOVE before installation :
- Adhesive tapes from all oil holes
- All transport covers
- Rust protectives from all joint faces and centering shoulders. These faces must be degreased and dry!

ENTFERNE vor Inbetriebnahme :
- Alle Anschlagmittel

REMOVE before initiation :
- All lifting appliances



VERWENDUNG DER ANSCHLAGMITTEL
USE OF LIFTING APPLIANCES

Zum Heben / For lifting Ohne Massstab / Not to scale Im Betrieb / During service

Nur hochfeste Anschlagmittel verwenden ! (z.B. RUD)
Use only high quality lifting appliances ! (e.g. RUD)



° Anschlagmittel nicht im Lieferumfang!
° Gesamtgewicht nicht an einem Anschlagmittel alleine heben !

° Lifting appliances are not supplied by Geislinger !
° Do not lift total mass on one lifting appliance only !

MONTAGEVORSCHRIFT FUER SCHRAUBEN
MOUNTING INSTRUCTIONS FOR BOLTS

1. Kontaktflaechen reinigen (fettfrei)
2. Alle gekennzeichneten Tellerfedern (Scheiben) beidseitig ausreichend mit spezifiziertem LOCTITE versehen. Gewindebehandlung lt. Tabelle

a) bei Anzugsmoment:
Schrauben laut Tabelle anziehen
(TOLERANZ ± 10%)
b) bei Verdrehwinkel:
□ Schraube anziehen bis Tellerfeder flach aufliegt bzw. angegebenes Voranlegemoment erreicht ist.
□ Danach Schraubenkopf um den angegebenen Verdrehwinkel weiterdrehen.

1. Surfaces must be cleaned (degreased)
2. Enough specified LOCTITE must be applied to both sides of all marked disc springs (washers).

Thread treatment according to table
a) if tightening torque is stated:
Tighten bolts acc. to table
(TOLERANCE ± 10%)
b) if twist angle is stated:
□ Tighten bolt until disc spring rests just flat on flange or use stated initial tightening torque.
□ Then turn bolt head further through the stated twist angle.

ACHTUNG: Werte f. Anzugsmomente bzw. Voranlegemomente sind nur bei Oberflaechenbehandlung laut Tabelle gueltig !

ATTENTION: Values for tightening torques (initial or final) are valid only if all surfaces are treated as stated below !

Teil Nr. Item no.	Anzugsmoment Tightening torque	Voranlegemoment Initial tightening torque	Verdrehwinkel Twist angle	Gewinde thread	Tellerfedern disc spring
750	140 Nm			Molykote 1000	Loctite 275
905	670 Nm			Loctite 243	Loctite 243

Schrauben lose beigelegt oder von Geislinger nur handfest angezogen !
Endgueltiges Festziehen der Schrauben lt. Montagevorschrift ist vom KUNDEN durchzufuehren!
Bolts only hand tightened by Geislinger or delivered in loose condition !
Bolts finally tightened by CUSTOMER at assembly according to mounting instruction !

TECHNISCHE DATEN / TECHNICAL DATA

Massen / Masses				Allgemeines / General	
	Massentrageheftsmoment Mass moment of inertia	Masse Mass	Motor type Engine type	5,6H21/32	
Aussen teil Outer member	9.58 kgm ²	145 kg	Dauernd zul. elastisches Moment Perm. elastic torque cont.	15.4 kNm	
Innen teil Inner member	0.49 kgm ²	20 kg	Kurzzeitig zul. el. Moment Trans. permissible elast. torque	23.1 kNm	
Gesamtmasse Total mass	166 kg		Zul. Daempfungsmoment pro bar Perm. damping torque per bar	1.32 kNm/bar	
Einzelmassen / Mass of items			Zul. Verlustleistung Perm. thermal load	8.2 kW	
Teil / item	ca. kg	Teil / item	ca. kg	Drehsteifigkeit Torsional stiffness	1.6 x 10 ⁸ Nm/rad
1,2,3	73			Daempfungskonstante Linear viscous damping	1400 Nms/rad
5	34			Oeldurchfluß / oil discharge	
7	34			3 bar Ueberdruck/gauge press. 4 bar abs. Druck/press.	ca. / approx. 5.4 l/min
9	20			Viskosität/viscosity 15 mm ² /s	
Nur fuer dick gezeichnete Teile gueltig Only valid for parts drawn in thick lines				Min. erforderl. Oeldruck lt. Drehschwingungsrechnung Min. required oil pressure acc. to TV-calculation	

Massstab / Scale 1:2	Erstellt/drawn Geändert/revised Geprüft/checked	2003-10-14 2003-10-15	H. Seidl M. Walzer	Stueckliste / Parts list G4 13544-
Benennung / Designation D 63/66 Daempfer / Damper				Zeichn. Nr. / Drg. Nr. G1 05805
Schutzvermerk nach DIN 34 beachten Allgemeintoleranzen nach DIN ISO 2768-mH		Copyright reserved General tolerances acc. to DIN ISO 2768-mH		GEISLINGER COUPLINGS AND DAMPERS, BUILT TO LAST.

part list		
item no.	number	designation
1	24	spring pack
2	24	intermediate piece
3	1	c.lamping ring
5	1	flange
7	1	side plate
9	1	innerstar
700	24	bronze spacer
701	a.r.	expansion shim
730	2	lifting appliance
750	24	hexagon bolt
810	24	disc spring
811	1	disc spring
850	2	o-ring
851	2	o-ring string
905	1	distributor bolt

ROSTSCHUTZ/KONSERVIERUNG NACH: "ANWEISUNG 4.5/9"
RUST INHIBITOR/PRESERVATION ACC. TO: "PROCEDURE 4.5/9"



Geislinger Coupling



Geislinger Damper



Geislinger Gesilco



Geislinger Flexlink



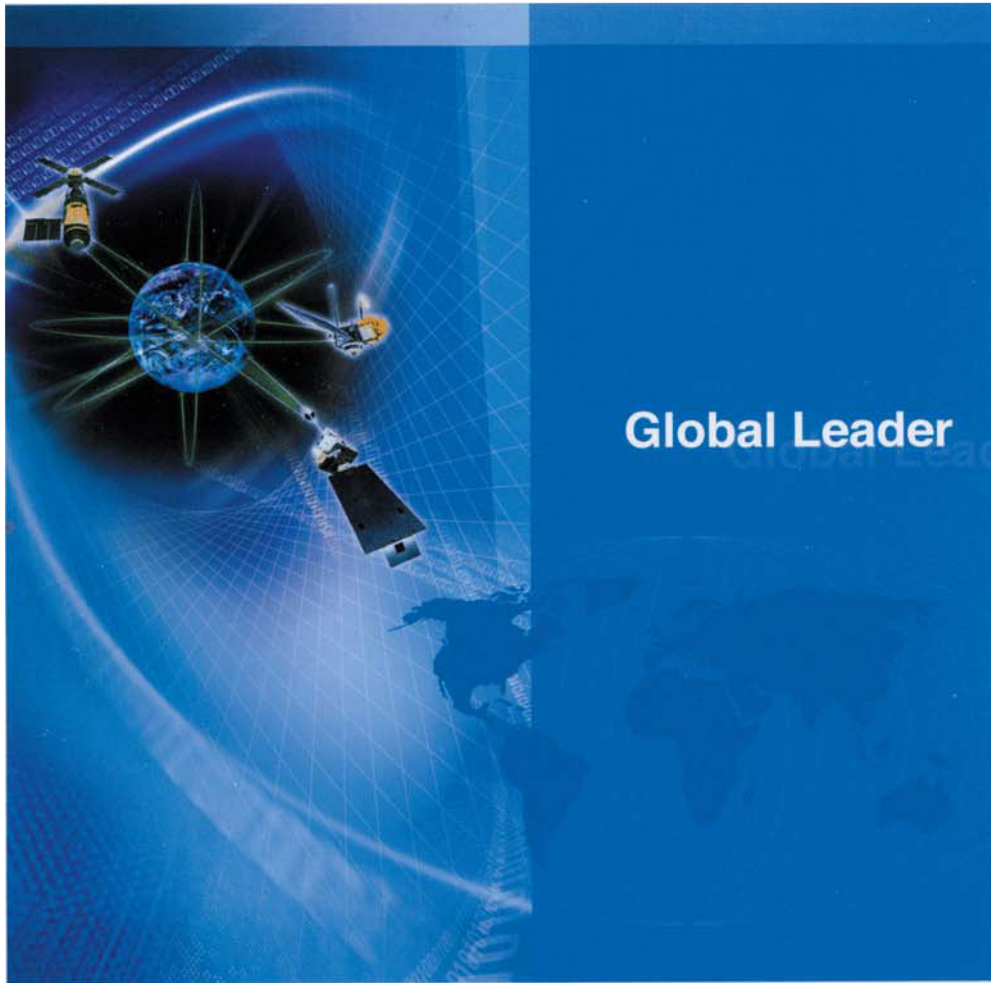
Geislinger Monitoring



Geislinger Carbotorq



Geislinger Vdamp



CUSTOMER : YANGFAN SHIPYARD
PROJECT NAME : YANGFAN 2003
REFERENCE NO. : APP-07RAL574-Rev.2
DATE ISSUED : Nov. 09, 2009
CLASS : ABS

SPECIFICATION for **SYNCHRONOUS GENERATOR** (1125 KVA, 8P, 450V, 60Hz, 3SETS)

FOR FINAL

2	Nov. 09, 2009	For Final	G.B.KIM	K.H.JEONG	-	D.S.KIM
1	Aug. 11, 2008	For Working	H.S.JUNG	-	O.S.SONG	H.W.KIM
0	Dec. 11, 2007	For Approval	H.S.JUNG	S.M.LEE	O.S.SONG	D.S.KIM
Rev.	Date Issued	Contents	Prepared by	Checked by	Checked by	Approved by

(TEL:82-52-202-6904, FAX:82-52-202-6995)


HYUNDAI HEAVY INDUSTRIES CO., LTD

Electro Electric Systems

<http://www.hhi.co.kr>

CONTENTS

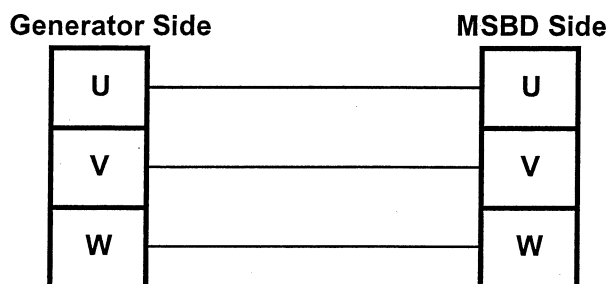
1	CAUTION	
2	SPECIFICATION OF GENERATOR	: HFC7 506-84K-Rev.1
3	PROCEDURE OF A.C GENERATOR TEST	: MG TA 1
4	SECTIONAL DRAWING	: 3G-003022-Rev.0
5	OUTLINE OF GENERATOR	: 3H-000019-Rev.3
6	DIMENSION OF SHAFT	: 3H-000020-Rev.1
7	TERMINAL BOX ASS'Y	: 3G-001777-Rev.1
8	AVR CONNECTION DIAGRAM	: 3G-002029-Rev.0
9	TERMINAL CONNECTION DIAGRAM	: 3G-002055-Rev.1
10	DROOP CHARACTERISTIC...	: 4G-000175-Rev.0
11	REFERENCE VALUE SETTER	: 3M-053674-Rev.0
12	SPARE PART FOR A.C GENERATOR	: 4M-023970-Rev.0
13	D/G SET PLAN VIEW	: 4M-057762-Rev.1
14	INSPECTION & TEST REPORT	

CAUTION

A. Phase Sequence

Phase sequence of these generators are U→V→W regardless of rotating direction of prime mover.

Please connect all cables as shown in below figure 1.



※ MSBD : Main Switch Board

< Figure 1 >

B. Manual Synchronizing

Please be careful at synchronizing of each generator during on board test or normal operating as follows.

- 1) Check that incoming generator voltage level and frequency in its no-load condition is correct.
- 2) After rotating the synchronizing switch to the "ON" position, please check the condition of the synchroscope pointer, and adjust the speed of the incoming Engine/Generator until it is rotating slowly to clockwise direction (no more than 1 revolution / 20 seconds).
- 3) The incoming generator breaker should be closed as close to the 12 o'clock position as possible.

Warning

If generator breaker is closed at conditions other than the above, the generator excitation system (Diodes, Varistors, Transformer ...) & rotor or stator can be damaged by transient reactive current.

SPECIFICATION OF GENERATOR

USE	DIESEL ENGINE GENERATOR			QUANTITY / SHIP	3ST / SHIP			
TYPE OF ENCLOSURE	IP 23			APPLIED CLASS	ABS			
COOLING SYSTEM	AIR TO AIR			AMBIENT TEMP.	50 °C			
EXCITING SYSTEM	SELF EXCITING BRUSHLESS			INSULATION CLASS	F			
STRUCTURE OF ROTOR	CYLINDRICAL ROTOR			TEMPERATURE RISE	F			
COUPLING METHOD	DIRECT DISK COUPLING			APPLIED UNIT	METRIC			
SPECIFICATION				BEARING				
TYPE	HFC7 506-84K			TYPE OF BEARING	SLEEVE BEARING			
OUTPUT CAPACITY	1125.0 KVA			LOCATION	DRIVED END	NON-DRIVED END		
RATING	CONTINUOUS			SIZE	-	Φ 100*L120		
PHASES, WIRE, CONN	3 Φ, 3 W, Y (DAMPER WINDING)			OIL QUANTITY	-	2.3 LITER		
VOLTAGE	AC 450 V			LUB SYSTEM	-	SELF LUB.		
CURRENT	1443.4 A			OIL GRADE	ISO VG 32			
FREQUENCY	60 Hz			INLET PRESSURE	- bar			
POLES	8 P			INLET TEMP.	Max	- °C		
SPEED	900 RPM			AIR COOLER				
POWER FACTOR	0.8 LAGGING			CAPACITY	-			
GD ² / J	293.6 Kg.m ² / 73.4 Kg.m ²			FLUID	-			
ROTOR WEIGHT	1700 Kg			QUANTITY	- m ³ /h			
TOTAL WEIGHT	4.3 ton			INLET TEMP.	- °C			
CHARACTERISTICS				TEMP RISE	- °C			
OVER CURRENT		REFER TO ITP		PRESSURE DROP	- Kg/cm ²			
VARIATION OF GENERATOR VOLTAGE		±2.5 %		DRY WEIGHT	- Kg			
OVER SPEED		120 % / 2 min.		DETECTING SYSTEM				
VOLTAGE ADJUST		±5.0 %		WINDING TEMP.	PT100 OHM × 2EA/PHASE			
MOUNTING METHOD		B5/B20		BEARING TEMP.	ROD TYPE + PT100OHM x 1EA/BRG.			
REACTANCE & TIME CONSTANT (CALCULATED VALUE)				COOLING AIR TEMP	-			
				LEAKAGE DETECTOR	-			
Xd	345 %(UNSATURATED)	T' d	0.0703 Sec.	CONFIRMED ITEM BY OWNER				
X' d	22 %(SATURATED)	T'' d	0.0028 Sec.	* LOCATION OF TERMINAL BOX. (VIEWD FROM PRIME MOVER)		ALL RIGHT SIDE 		
X'' d	13 %(SATURATED)	Ta	0.0202 Sec.					
ra	1.9 %			* CABLE ENTRY		ALL TOP SIDE 		
NOTE				* SPACE HEATER		1PH, AC 220V, 315W		
* WTD - ALARM : 150°C - TRIP : 155°C * BTD - ALARM : 90°C - TRIP : 95°C				* PAINTING COLOR		7.5 BG 7/2		
				* LOCATION OF AIR COOLER FLANGE (VIEWD FROM PRIME MOVER)				
				* ROTATING DIRECTION OF GENERATOR (VIEWD FROM PRIME MOVER)		C.C.W		
				REMARK				
REV	CONTENTS		DATE	1.THE SPECIFICATION OF * MARK SHOULD BE INFORMED ON YOUR APPROVED DRAWING				
1								
2				HFC7 506-84K-Rev.1				
3				DATE	DESIGN	CHECKED	CHECKED	APPROVED
4				Dec. 11, 2007	H.S.JUNG	-	O.S.SONG	H.W.KIM
5								

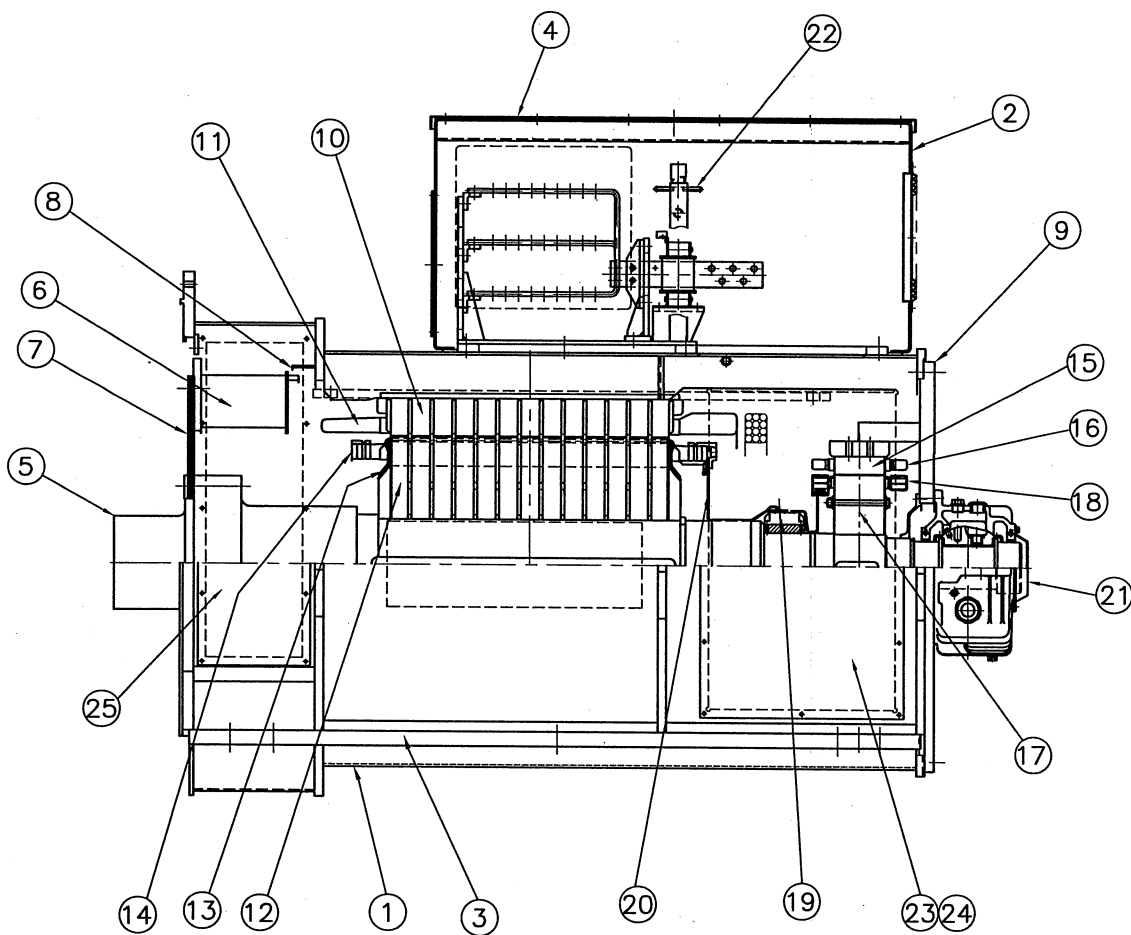
TEST PROCEDURE OF A.C SYNCHRONOUS GENERATOR			MG TA 1	1 / 2
No	Test Item	Procedure	Criterion	Remarks
1	Temperature Rise Test	The generator will be operated with rated current until the temperature of each section are saturated according to IEEE115. Temperature rise of each winding will be measured by resistance method.	Stator : < 95°C Rotor : < 100°C	Type Test
2	Overcurrent Test	The generator will have to withstand 50% excess of rated current for 30 seconds after temperature rise test.	Without damage visually	Type Test
3	Overspeed Test	Overspeed test will be carried out for 120 seconds with 1.2 times the rated speed under no excitation condition.	Without damage visually	
4	Dielectric Strength Test	The test voltage with commercial frequency will be applied to each winding for 60 seconds.	Stator : 2,000 V Rotor : 1,500 V	
5	Measurement of Insulation Resistance	Insulation resistance of each separate winding will be measured with DC megger before and after high voltage test.	More than 5MΩ	
6	Measurement of Winding Resistance	Each winding resistance will be measured by volt-ampere method.		
7	Verification of the voltage regulation system	The generator, together with its voltage regulation system, will be verified in such a way that, at all loads from no-load running to full load, the rated voltage at the rated power factor is maintained within ±2.5% under steady condition. Test shall be carried out at zero (0) factor load according to approval drawing.		

TEST PROCEDURE OF A.C SYNCHRONOUS GENERATOR			MG TA 1	2 / 2
No	Test Item	Procedure	Criterion	Remarks
8	Steady State Short Circuit Test	After power circuits are shorted with no excitation, giving excitation while running at rated revolution, the generator with excitation systems will have to withstand 300% rated current for 2 seconds.	Without damage visually	Type Test
9	Momentary Voltage Variation Test	The momentary voltage variation shall be measured and calculated by equivalent method of JEM(Japanese Electrical Manufacturer's Association) 1354. The equivalent calculation method are as follows. $\Delta V = \frac{V - V_{min}}{V - V_{min} + (I_s \times X_e)/100} \times 100 (\%)$ V : Rated Voltage (%) Vmin : Minimum Voltage when applying the load (%) Is : Load Current in Vmin (%) Xe : Impedance of applied load (%) * The recovery time within $\pm 3.0\%$ of the rated voltage shall be checked during engine's governor characteristic test at engine's shop.	Less than 15% of rated voltage, at least 60% of the rated current of generator with power factor of 0.4 lagging or less.	Type Test
10	Verification of Bearing	Upon completion of the test, the bearing shall be overhauled.	Without damage visually	
11	Air Gap Measurement	Measurement record to be submitted to the surveyor.		
12	Running Balance Test	Generator will be operated at no load and rated speed. The vibration of the machine and operation of the bearing lubrication system will be checked.		

※1. Type Test : Test of the first generator of a series.

※2. Above test items & procedure are satisfied with ABS requirement.

Rev.2



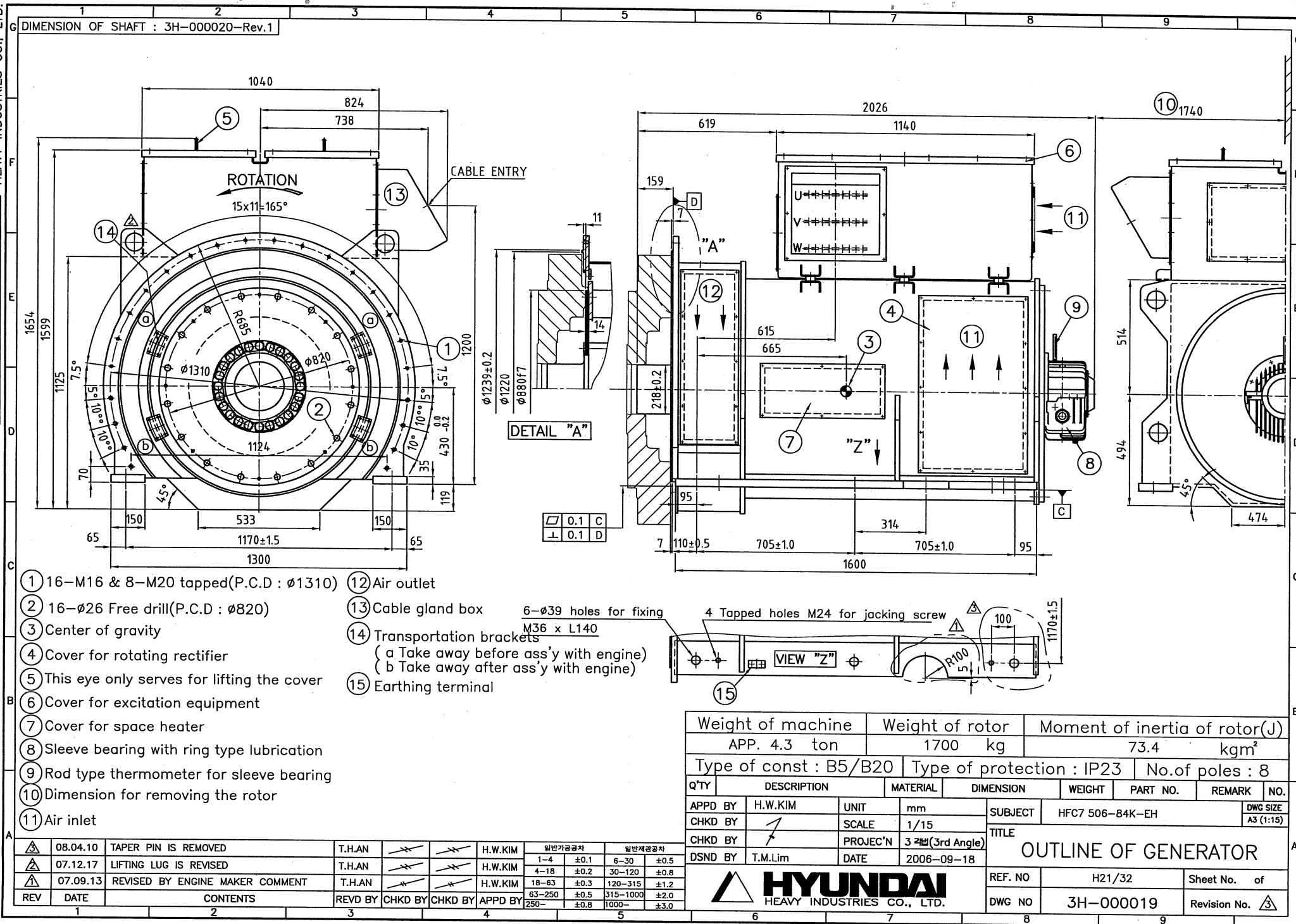
NOTE

THIS DRAWING DEFINES GENERAL CONCEPT OF GENERATOR,
IT MAY BE DIFFERENT IN REAL CONFIGURATION AND DETAIL DEMENSIONS.

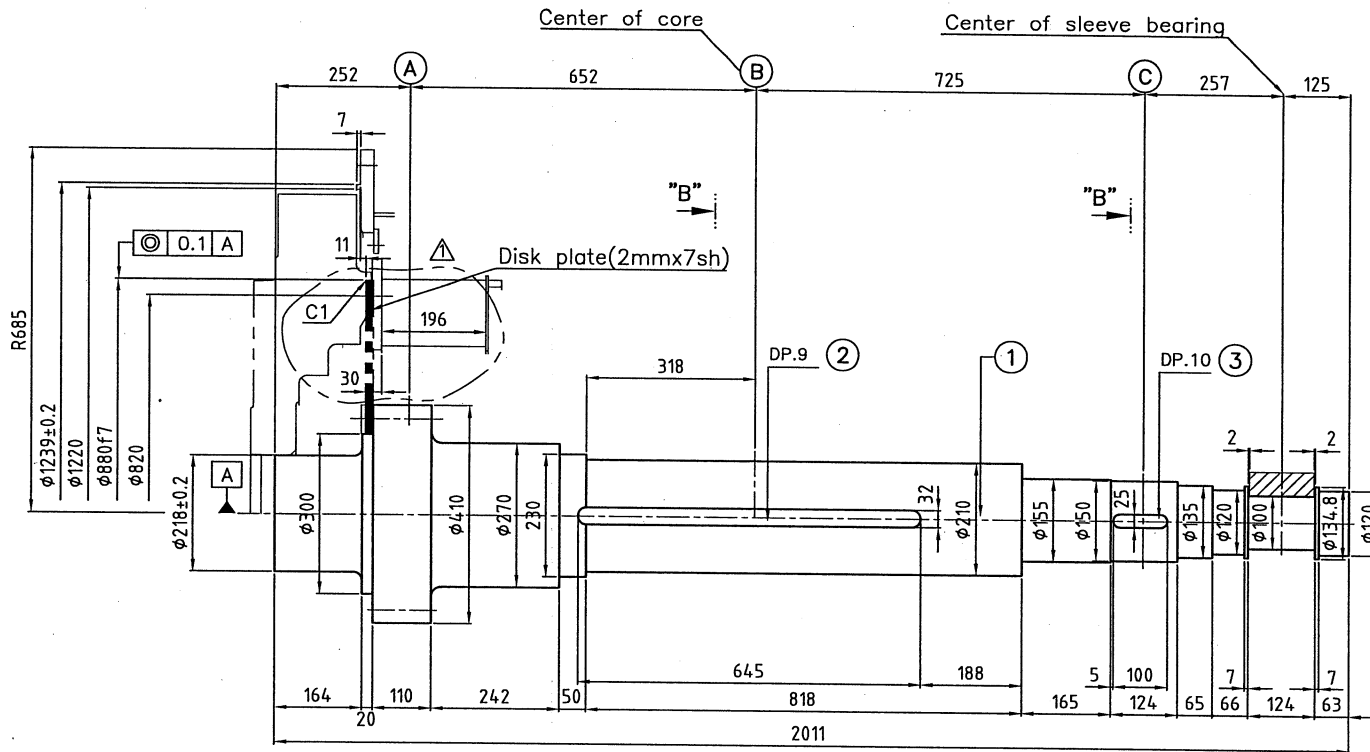
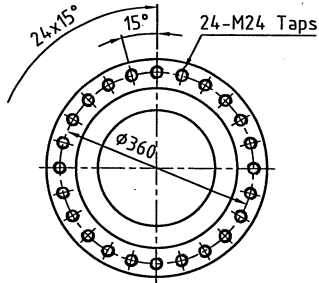
—	AIR OUTLET VENT COVER		25
—	AIR FILTER		24
—	AIR INLET VENT COVER		23
1	EX. EQ. ASS'Y		22
1	SLEEVE BEARING	CAST IRON & WHITE METAL	21
2	RECTIFIER LEAD	CU	20
—	ROTATING RECTIFIER	CAST IRON	19
—	EXCITER ROTOR WIND'G	CU	18
—	EXCITER ROTOR CORE	SI-STEEL	17
—	POLE WIND'G	CU	16
1	POLE CORE	MILD STEEL	15
—	ROTOR WIND'G	CU	14
—	DAMPER WIND'G	CU	13
—	ROTOR CORE	SI-STEEL	12
—	STATOR WIND'G	CU	11
—	STATOR CORE	SI-STEEL	10
1	END SHIELD (N.D.E)	MILD STEEL	9
1	AIR GUIDE (D.E)	MILD STEEL	8
1	COUPLING PLATE	SPCC	7
1	FAN	MILD STEEL	6
1	SHAFT	FORGED STEEL	5
1	EX. EQUIPMENT HOUS'G COVER	MILD STEEL	4
1	EARTHING TERMINAL	MILD STEEL	3
1	EX. EQUIPMENT HOUS'G	MILD STEEL	2
1	FRAME	MILD STEEL	1
Q'TY	DESCRIPTION	MATERIAL	NO.

Q'TY	DESCRIPTION	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	H.W.KIM	UNIT	MM	SUBJECT	HFC7 50.FRAME	CAD PROJ	FILE
Q.P. CHK		SCALE	N/S	TITLE	SECTIONAL DRAWING		
CHKD BY		PROJEC'N	3 각법 (3rd Angle)	REF. NO.		Sheet No.	of
DSND BY	H.S.JUNG	DATE	2007.5.31	DWG NO.	3G-003022	Revision No.	0

REV	DATE	CONTENTS	REVD BY	CHKD BY	CHKD BY	APPD BY
1						
2						
3						
4						



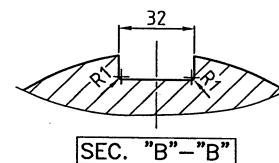
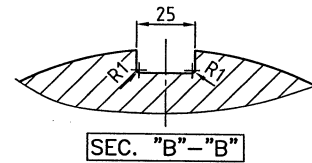
OUTLINE OF GENERATOR : 3H-000019-Rev.1



Coupling stiffness : 571.8(MNm/rad)

		WEIGHT (Kg)	INERTIA : J MOMENT(Kgm ²)
1	Ⓐ FAN	141	19.5
2	Ⓑ CORE WITH WINDING	850	45.0
3	Ⓒ EXCITER	120	3.6
4	SHAFT	589	5.3
5	ROTOR COMPLETE	1700	73.4

$$GD^2 = 4J$$

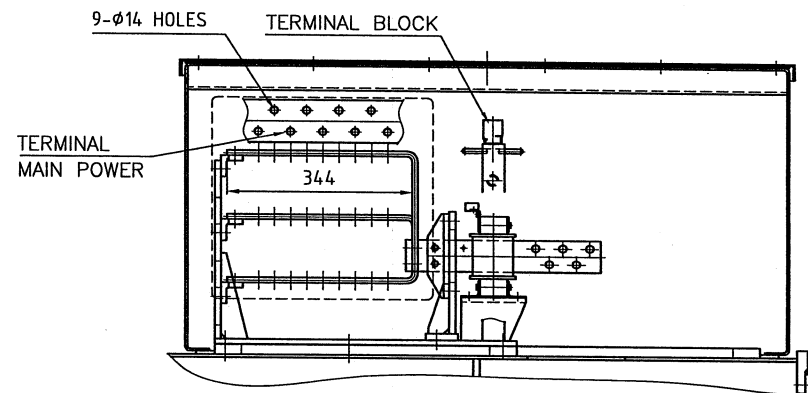
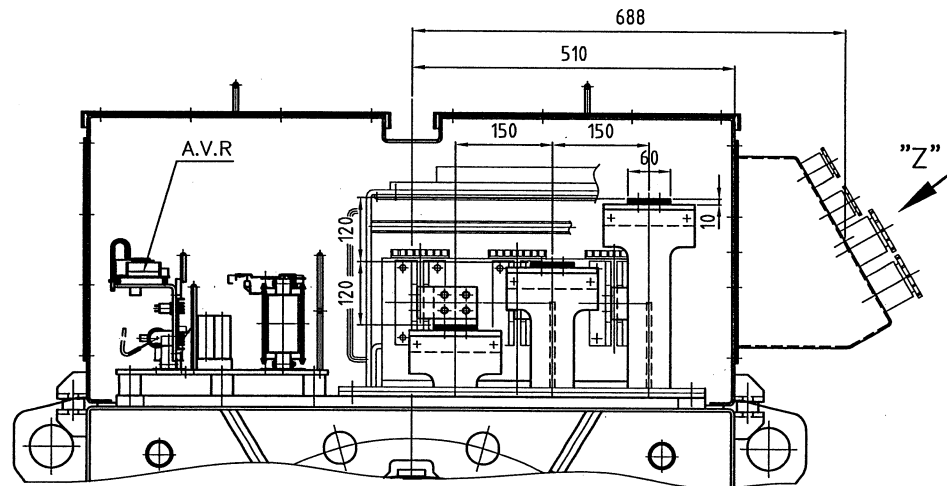


1	KEY		A25 x 14 x 100				3
1	KEY		A32 x 18 x 645				2
1	SHAFT	SF590A	φ410 x L2011	761 Kg			1
Q'TY	DESCRIPTION	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	H.W.KIM	UNIT	mm	SUBJECT	HFC(J)7 506-84K-EH		
CHKD BY		SCALE	1/10	TITLE	DIMENSION OF SHAFT		
CHKD BY		PROJEC'N	3 각법(3rd Angle)	REF. NO	H21/32	Sheet No.	of
DSND BY	T.M.Lim	DATE	2006-09-18	DWG NO	3H-000020	Revision No.	△

▽	50S
▽▽	12.5S
▽▽▽	3.2S
▽▽▽▽	0.4S

REV	DATE	CONTENTS	REVD BY	CHKD BY	CHKD BY	APPD BY
1	07.09.13	REVISED BY ENGINE MAKER COMMENT	T.H.AN			H.W.KIM

일반가공공차		일반가공공차	
1-4	±0.1	6-30	±0.5
4-18	±0.2	30-120	±0.8
18-63	±0.3	120-315	±1.2
63-250	±0.5	315-1000	±2.0
250-	±0.8	1000-	±3.0



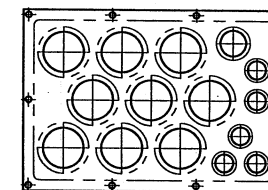
D.E

N-D.E

1

NOTE	CABLE SIZE	Q'TY	CABLE GLAND
FOR MAIN POWER	φ 47 mm	9	55B
FOR REFERENCE VALUE SETTER	φ 19 mm	1	25C
FOR W.T.D	φ 29 mm	1	35B
FOR B.T.D	φ 16 mm	1	25A
FOR VOLTAGE SENSING	φ 16 mm	1	25A
FOR PRE-EXCITING	φ 16 mm	1	25A
FOR SPACE HEATER	φ 16 mm	1	25A

1



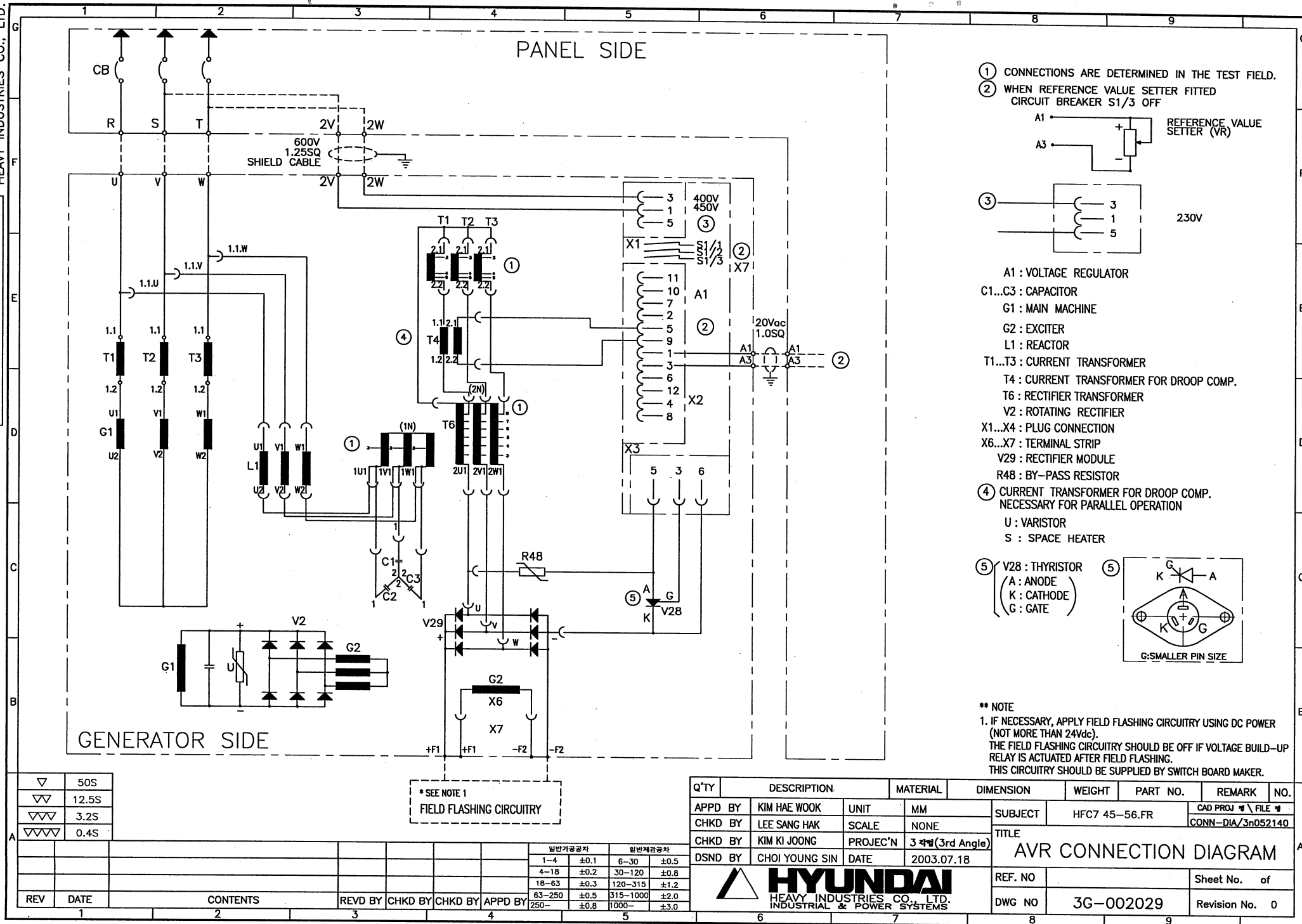
VIEW "Z"

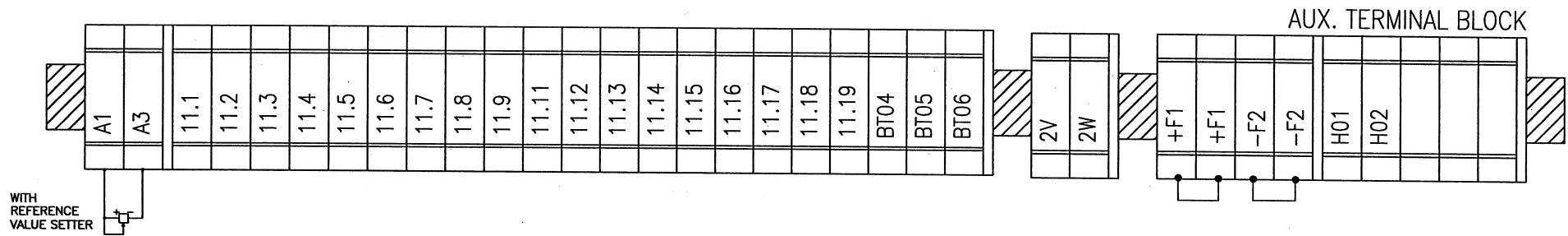
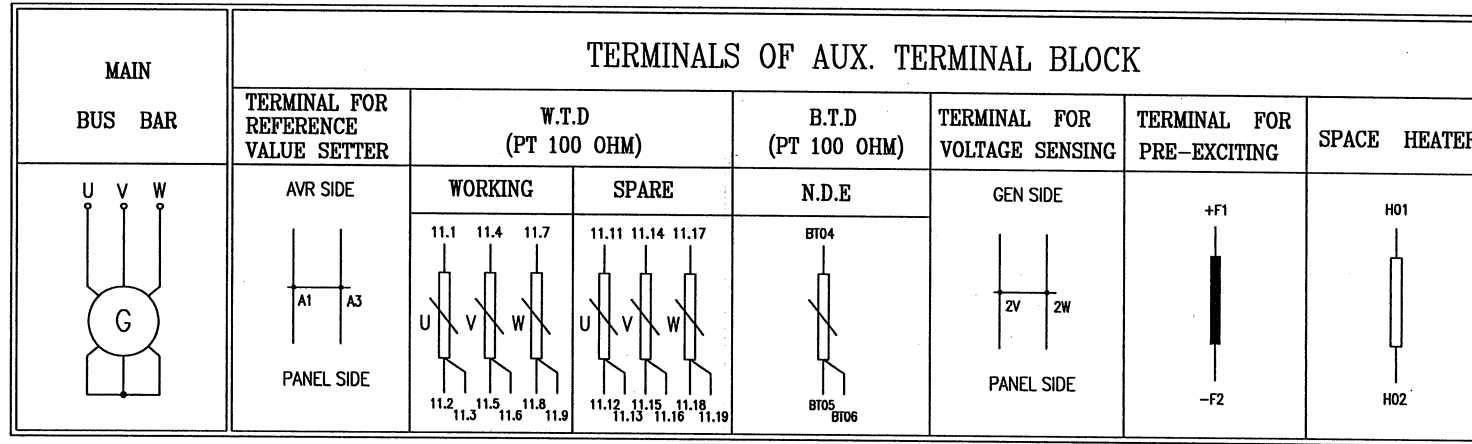
* CORE OF MAIN POWER CABLE GLAND TO BE USED 3C CABLE FOR 3 PHASE.

▽	50S
▽▽	12.5S
▽▽▽	3.2S
▽▽▽▽	0.4S

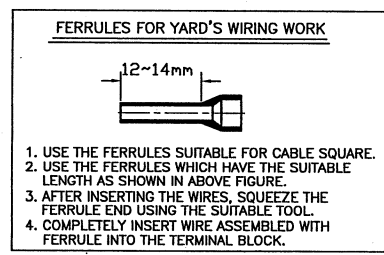
REV	DATE	CONTENTS	REVD BY	CHKD BY	CHKD BY	APPD BY
1	2008.08.11	REVISED BY OWNER'S COMMENT	H.S.JUNG			H.W.KIM

Q'TY	DESCRIPTION	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	H. W. KIM	UNIT	mm	SUBJECT	HFC7 50.FR	DWG SIZE	
CHKD BY	S. J. LEE	SCALE	NON SCALE	TITLE	T/BOX ASS'Y		
CHKD BY	—	PROJEC'N	3 각법(3rd Angle)	REF. NO		Sheet No.	of
DSND BY	Y.H.Lee	DATE	2006-12-22	DWG NO	3G-001777	Revision No.	1





WITH
REFERENCE
VALUE SETTER



* LEGEND

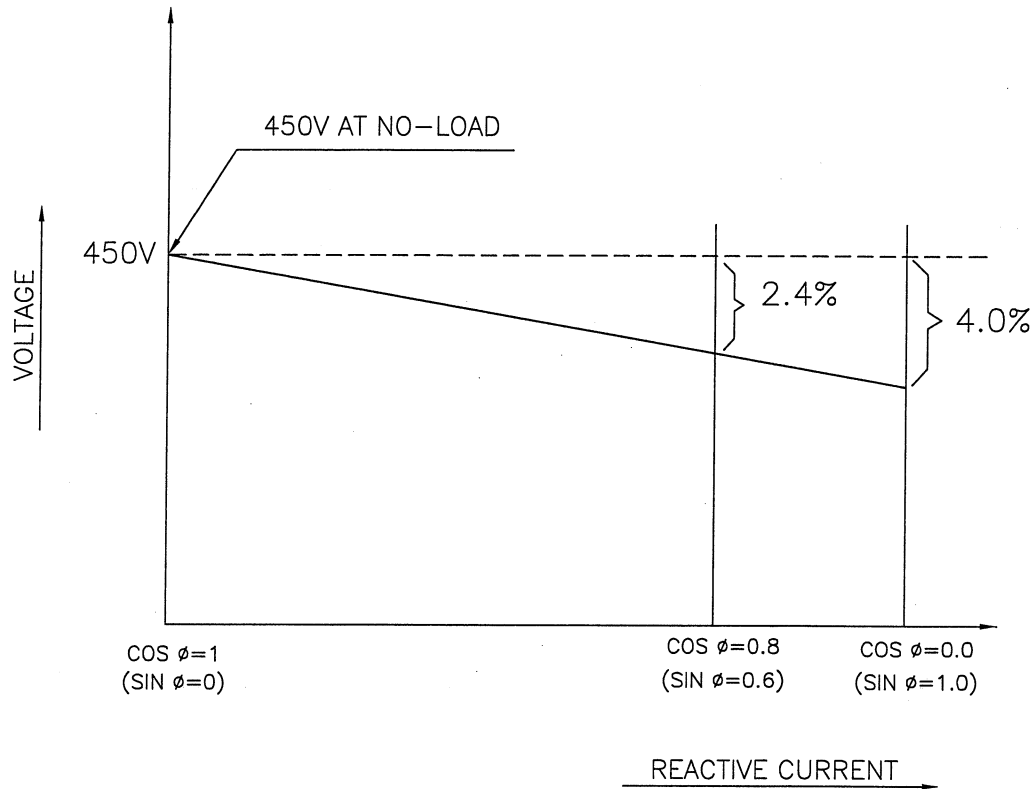
- 1) B.T.D : BEARING TEMPERATURE DETECTOR
- 2) W.T.D : WINDING TEMPERATURE DETECTOR
- 3) N.D.E : NON-DRIVE END SIDE

△	21/06/07	DELETE OF LEGEND NO.4	S.R.CHOI	K.J.KIM	S.H.LEE	H.W.KIM
REV	DATE	CONTENTS	REV'D BY	CHK'D BY	Q.P. CHK	APP'D BY
1						
2						
3						
4						

Q'TY	DESCRIPTION	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APP'D BY	H.W.KIM	UNIT	MM	SUBJECT	HFC6&7	CAD PROJ #	FILE #
Q.P. CHK	S.H.LEE	SCALE	N/S			GEN-SPEC\3G-002055	
CHK'D BY	K.J.KIM	PROJEC'N	3 차(3rd Angle)	TITLE	TERMINAL CONNECTION DIAGRAM		
DSND BY	S.R.CHOI	DATE	2007.05.07	REF. NO		Sheet No.	of
 ELECTRICAL ENGINEERING CO., LTD.				DWG NO	3G-002055	Revision No.	△

THIS DRAWING IS PROPRIETARY TO HEECO. NO PART OF THIS DRAWING
MAYBE REPRODUCED WITHOUT THE PERMISSION OF HHI.

REV	DATE	CONTENTS	REVD BY	CHKD BY	CHKD BY	APPD BY



VOLTAGE DROOP SET

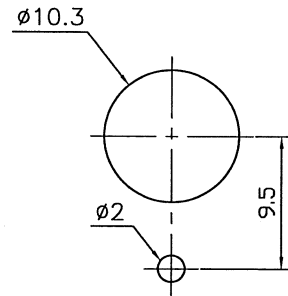
** The generator voltage, from no load to rated load, shall be maintained within $\pm 2.5\%$ according to classification requirements.

Q'TY	DESCRIPTION	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	H.W.Kim	UNIT	MM	SUBJECT	FOR 450V	CAD PROJECT \ FILE	
Q.P CHK	S.H. Lee	SCALE	N/S			SPEC/4G000175	
CHKD BY	K.J. Kim	PROJEC'N	3rd Angle	TITLE DROOP CHARACTERISTIC OF SYNCHRONOUS GENERATOR			
DSND BY	T.Y. Cho	DATE	2006.01.25				
				REF. NO		Sheet No.	of
				DWG NO	4G-000175	Revision No.	0

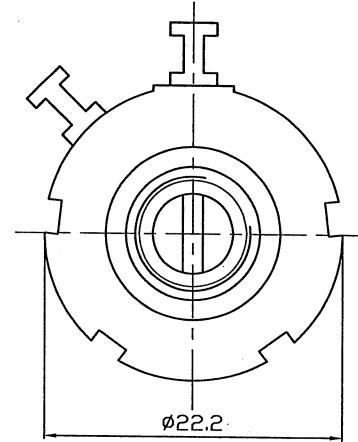
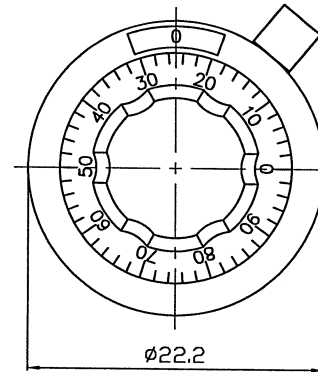
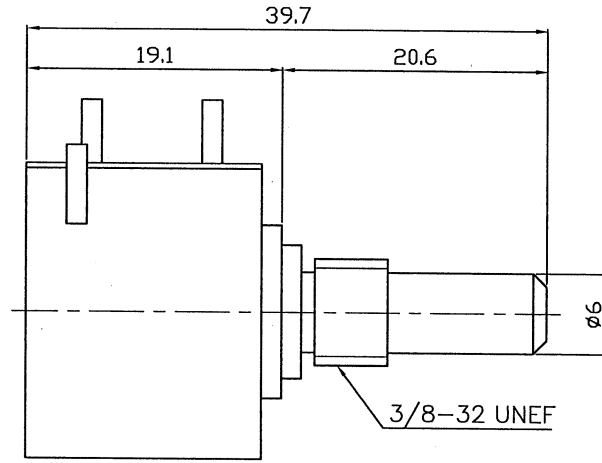
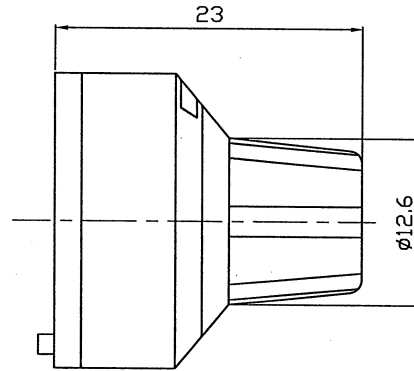
본 도면은 현대중공업(주) 재산이므로
허가없이 복사할 수 없음 (취급주의)

THIS DRAWING IS PROPRIETARY TO HHI. NO PART OF THIS DRAWING
MAY BE REPRODUCED WITHOUT THE PERMISSION OF HHI.

HYUNDAI
HEAVY INDUSTRIES CO., LTD.



CUTT'G HOLE FOR
PANEL MOUNT'G

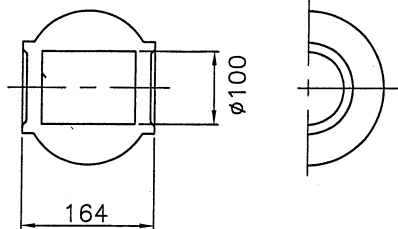


▽	50S
▽▽	12.5S
▽▽▽	3.2S
▽▽▽▽	0.4S

REV	DATE	CONTENTS	REVD BY	CHKD BY	CHKD BY	APPD BY	DATE	REMARK
1								
2								
3								
4								
5								

Q'TY	DESCRIPTION	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	H.W.KIM	UNIT	MM	SUBJECT	5 KOHM, 2W	CAD PROJ # \ FILE #	
CHKD BY	S.H.LEE	SCALE	N/S			ACCY-ATT/3R053674	
CHKD BY		PROJEC'N	3 각법 (3rd Angle)	TITLE	REFERENCE VALUE SETTER		
DSND BY	KIM KI JUNG	DATE	2002.12.03	REF. NO		Sheet No.	of
				DWG NO	3M-053674	Revision No.	0

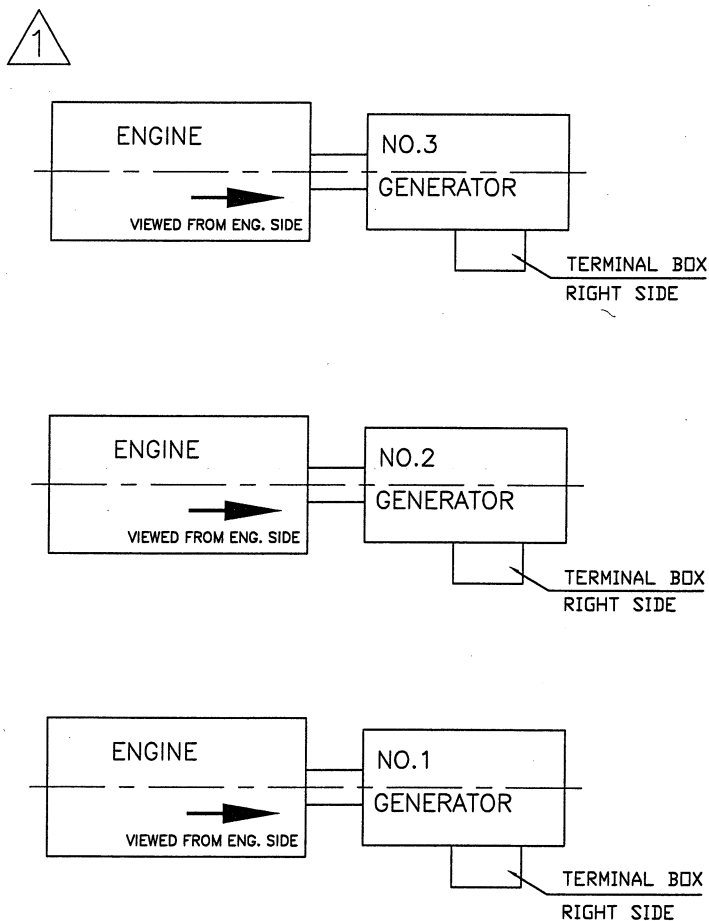
HYUNDAI
HEAVY INDUSTRIES CO., LTD.
INDUSTRIAL & POWER SYSTEMS

SPARE PART FOR A.C GENERATOR			DWG. NO.	4M-023970		1/1
ITEM NO.	NAME OF PARTS	OUTLINE	QUANTITY			REMARK
			WORKING		SPARE	
			SET	PER VESSEL		
1	BEARING SHELL		1	3	1	PH100XL120 (SELF LUB)

▽	50S	REV	DATE	CONTENTS	REVD BY	CHKD BY	CHKD BY	APPD BY
▽▽	12.5S	△1	2008.08.11	REVISED BY SHIPYARD'S COMMENT	H.S.JUNG	///	///	H.W.KIM
▽▽▽	3.2S							
▽▽▽▽	0.4S							

A. LOCATION OF TERMINAL BOX : ALL RIGHT SIDE △1
(VIEWED FROM ENGINE SIDE)

B. CABLE ENTRY (TOP or BOTTOM) : ALL TOP SIDE △1



Q'TY	DESCRIPTION		MATERIAL	DIMENSION		WEIGHT	PART NO.	REMARK	NO.
APPD BY	D. S. KIM	UNIT	MM	SUBJECT				CAD PROJ 8 \ FILE 8	
CHKD BY	S. H. LEE	SCALE	NS					/G-ASS'Y/4R057762	
DSND BY	S. J. LEE	PROJEC'N	3 각법(3rd Angle)	TITLE D/G SET PLAN VIEW					
TRCD BY	KIM JOO HYONG	DATE	2000.06.13						
 HYUNDAI ELECTRICAL ENGINEERING CO., LTD.				REF. NO				Sheet No. of	
				DWG NO	4M-057762			Revision No. △1	



HEAVY INDUSTRIES CO.,LTD.
ELCTRO ELECTRIC SYSTEMS

HEAD OFFICE

#1.CHEONHA_DONG, DONG_GU, ULSAN KOREA
TEL: (052)202-6771.2 FAX: (052)202-6780

SEOUL OFFICE

HYUNDAI B/D, KYE_DONG CHONGRO_GU SEOUL KOREA
TEL: (02)746-7650-2

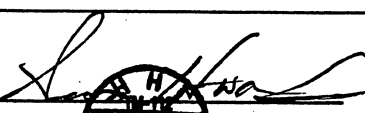
INSPECTION & TEST REPORT

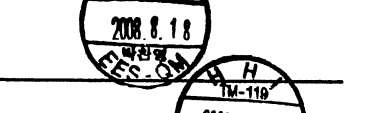
Customer :	HONGGUAN/ZJHG2001		
Project No.	20073405RAL574	Date of Test :	2008/08.18
Type :	HFC7 506-84K	Voltage :	3 phase ~ 450V , 60 Hz
Capacity :	1125 KVA * 3 Units	Serial No.	20073405RAL57401~03

TEST ITEMS

1. VISUAL & DIMENSIONAL INSPECTION
2. MEASUREMENT OF WINDING RESISTANCE
3. MEASUREMENT OF INSULATION RESISTANCE
4. TEMPERATURE RISE TEST
5. OVER LOAD TEST
6. OVER SPEED TEST
8. STEADY STATE SHORT CIRCUIT TEST
9. VOLTAGE REGULATION SYSTEM TEST

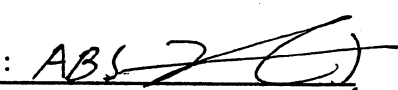
TEST RESULT : **GOOD**

Approved By : 

Checked By : 

Tested By : 

Reviewed and

Witnessed By : 

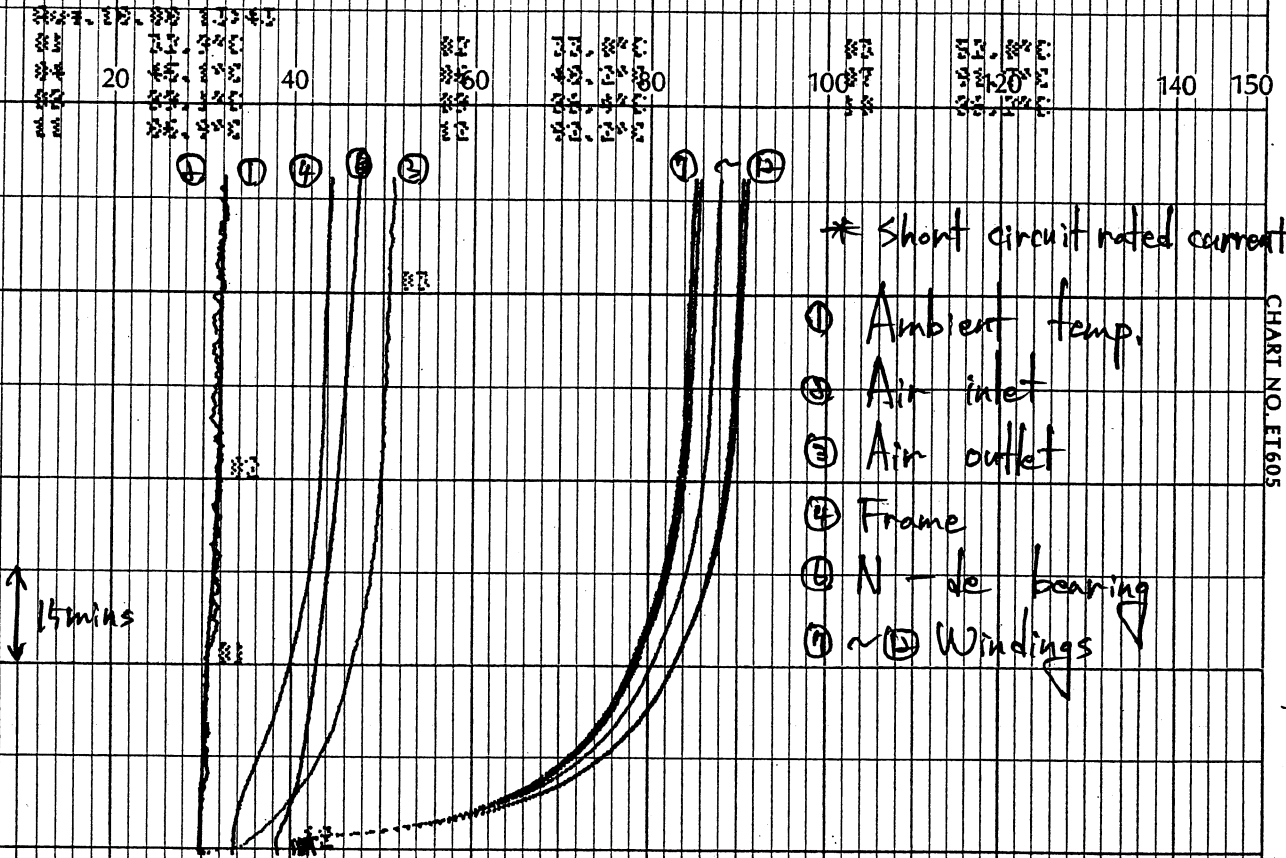
D. H. JEON

2008-08-18

UL 1042364

		TEST REPORT OF GENERATOR					R/M TEST SHOP		
Type : <u>HFC7 506-04K (IP 23)</u> Serial No : <u>20073405RAL57401</u>									
1. Temperature test: <u>450</u> V, <u>1443.4</u> A, $\cos \phi =$ <u>X</u> Field = <u>V</u> A									
Time	Stator			Exciter field		Remark			
	Voltage(V)	Current(A)	Frequency(Hz)	Voltage(V)	Current(A)				
<u>11:50</u>	<u>X</u>	<u>1443.4</u>	<u>60</u>	<u>53.1</u>	<u>3.92</u>	<u>short circuit rated current</u>			
<u>13:30</u>		<u>1443.4</u>	<u>60</u>	<u>56.5</u>	<u>3.97</u>				
Temp. run time :		Winding resistance(Ω)		Temp. rise by resistance method(K)		Temp. rise by E.T.D method (K)		Remark	
Hr mins									
Ambient / Coolant temp ($^{\circ}\text{C}$)		Stator (U-V)	Rotor (I-k)	Stator	Rotor				
Cold	<u>20</u>	<u>0.005123</u>	<u>1.0180</u>						
Warm									
2. Over current test : <u>150</u> % of rated current (<u>2165.1</u> A) for <u>30</u> secs									
3. Over speed test : <u>120</u> % of synch. speed (<u>1080</u> rpm) for <u>120</u> secs									
4. Open circuit characteristic test				5. Short circuit, characteristic test					
Voltage(V)	Field(A)	Voltage(V)	Field(A)	Current(A)	Field(A)	Current(A)	Field(A)	Remark	
				<u>* Steady state short circuit test</u>					
				<u>1443.2 X 3 = 4330.2(A)</u>					
				<u>ACT : 4400</u>					
				6. Load test at $\cos \phi = 0$					
				Voltage(V)	Current(A)	%	Remark		
				<u>450</u>	<u>0</u>	<u>0%</u>			
				<u>444.4</u>	<u>721</u>	<u>50%</u>			
				<u>436.4</u>	<u>1443</u>	<u>100%</u>			
7. Phase Voltage Comparison : U - V = <u>450</u> V, V - W = <u>450</u> V, W - U = <u>450</u> V									
8. Exciter data : U = <u>50</u> S = <u>40</u> T = <u>55</u> K = <u>20</u> R47 = <u>10</u> R1 =									
Rectifier Transformer(T6) : <u>5.5.5 / 5.4.5</u> Current transformer(T1,T2,T3) : <u>2.1 - 2.6</u>									
Reactor(L1) : <u>U1 - U2 2.0mm</u> Capacitor(C1) : <u>143</u> Thyristor controller(R2) :									
Adjustment : $U_{\text{sol}} =$ V.R = T.N =									
Others :									
9. High voltage test : <u>space heater : 1500V</u> Stator = AC <u>2000</u> V for <u>60</u> secs Rotor = AC <u>1500</u> V for <u>60</u> secs				10. Insulation resistance					
					Before H.V test		After H.V test		
				Stator	<u>500</u>	<u>MQ</u>	<u>500</u>	<u>MQ</u>	
	Rotor	<u>500</u>	<u>MQ</u>	<u>500</u>	<u>MQ</u>				
11. Phase sequence : U.V.W. viewed from D.E <u>←</u>				Space heater	<u>1000</u>	<u>MQ</u>	<u>1000</u>	<u>MQ</u>	
12. Other data :				<u>ABS</u> <u>D.H. 5604</u> <u>2008-08-18</u>					
Tested by : <u>2008.8.18</u>									

* Hongguan / ZJHG 2001
 1125 KVA. BP. 450V. 60HZ
 20073405 RAL 57401



* Short circuit rated current

- ① Ambient temp.
- ② Air inlet
- ③ Air outlet
- ④ Frame
- ⑤ N-de bearing
- ⑦ ~ ⑫ Windings

CHART NO. ET605

ABS

[Signature]
 D.H. JEON

2008-08-18

© SAM SUNG CHART



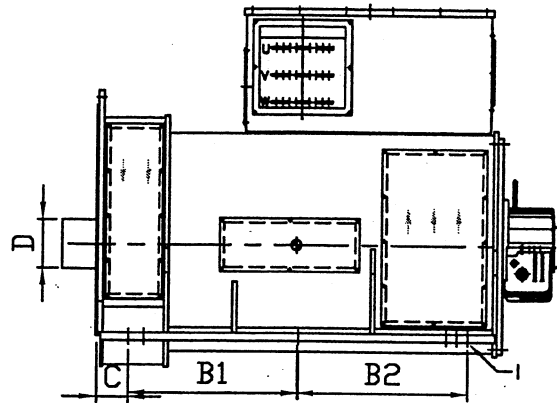
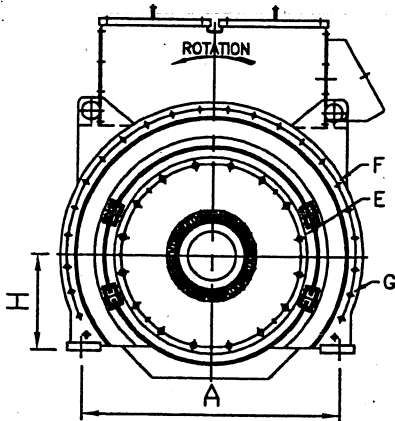
INSPECTION REPORT

검사 성적서

CHECKED BY :
검 토 자

PROJ. NO. 수주번호	20073405RAL574	SPEC 용량,형식	900KW,8P,450V	INSP. DATE 검 사 일	2008.08.17
CUSTOMER 수 주 처	Hongguan	DWG. NO. 도면번호	3H-000019	INSPECTOR 검 사 자	S.K.SEOK
PROJ.NAME 수 주 명	ZJHGG2001	Q'TY 수 량	3SET(NO: 1)	SERIAL NO. 일련번호	✕

FINAL CHECK SHEET(D)

# DIMENSION #
(치 수)

PART (구분)	MK (기호)	A	B1	B2	C	D	E	F	G	H	I	
SPEC(치수)		±1.5 1170	±1.0 705	±1.0 705	±0.5 110	±0.2 Ø218	16-Ø26	16-M16	8-M20	-8 ₂ 430	6-Ø39	
MEASURE(측정)		+0.2	+0.1	+0.1	-0.2	+0.1	16-Ø26	16-M16	8-M20	-0.14	6-Ø39	

(검 사 표)

NO. (번호)	ITEM (항목)	STD&DWG (도면)	CHECK (검사)	RESULT (결과)	REMARK (비고)
1	POSITION OF TERMINAL BOX 단자함 위치	APPROVAL SPEC	G	G	
2	CABLE GLAND SIZE & ARRANGE CONDITION 인출부 치수 및 나열상태	APPROVAL SPEC	G	G	
3	BEARING CONDITION 베어링 상태	APPROVAL SPEC	G	G	
4	COVER ASSEMBLY CONDITION 카바 조립 상태	APPROVAL SPEC	G	G	
5	DAMAGE OF EACH PARTS 각 부품의 흠집	APPROVAL SPEC	G	G	

NOTE(특기)

VISUAL INSPECTION : GOOD

유점 참조(계측기 사용 LIST)

G : GOOD NG : NO GOOD NA : NOT APPLICATION
(양호) (불량) (해당없음)

FINAL INSPECTION

최 종 판 정

☒ ACCEPT

		TEST REPORT OF GENERATOR				R/M TEST SHOP		
Type : <u>HFC7 506-84K (IP 23)</u> Serial No : <u>20073405RAL57402</u>								
1. Temperature test: <u>450</u> V. <u>1443.4</u> A. $\cos \phi = \text{---}$ Field = <u>55.4</u> V <u>3.94</u> A								
Time	Stator			Exciter field		Remark		
	Voltage(V)	Current(A)	Frequency(Hz)	Voltage(V)	Current(A)			
04:50	450	---	60	16.4	1.25	Open circuit rated voltage		
05:50	450		60	16.7	1.27			
06:00	---	1443.4	60	51.9	3.89	Short circuit rated current		
07:30		1443.4	60	55.4	3.94			
Temp. run time :		Winding resistance(Ω)		Temp. rise by resistance method(K)		Temp. rise by E.T.D method (K)		
Hr mins								
Ambient / Coolant temp ($^{\circ}\text{C}$)		Stator (U-V)	Rotor (I-k)	Stator	Rotor			
Cold	<u>29</u>	<u>0.005115</u>	<u>1.0181</u>					
Warm								
2. Over current test : <u>150</u> % of rated current (<u>2165.1</u> A) for <u>30</u> secs								
3. Over speed test : <u>120</u> % of synch. speed (<u>1080</u> rpm) for <u>120</u> secs								
4. Open circuit characteristic test				5. Short circuit. characteristic test				
Voltage(V)	Field(A)	Voltage(V)	Field(A)	Current(A)	Field(A)	Current(A)	Field(A)	
				6. Load test at $\cos \phi = 0$				
				Voltage(V)	Current(A)	%	Remark	
				<u>450</u>	<u>0</u>	<u>0%</u>		
				<u>444</u>	<u>721</u>	<u>50%</u>		
				<u>435.2</u>	<u>1443</u>	<u>100%</u>		
7. Phase Voltage Comparison : U - V = <u>450</u> V, V - W = <u>450</u> V, W - U = <u>450</u> V								
8. Exciter data : U = <u>52</u> S = <u>40</u> T = <u>55</u> K = <u>20</u> R47 = <u>10</u> R1 =								
Rectifier Transformer(T6) : <u>5.5.5-5.4.5</u> Current transformer(T1,T2,T3) : <u>2.1-2.6</u>								
Reactor(L1) : <u>41-42 2.0mm</u> Capacitor(C1) : <u>143</u> Thyristor controller(R2) :								
Adjustment : Usoll = V.R = T.N =								
Others :								
9. High voltage test : <u>Space heater : 1500 [V]</u> Stator = AC <u>2000</u> V for <u>60</u> secs Rotor = AC <u>1500</u> V for <u>60</u> secs				10. Insulation resistance				
					Before H.V test		After H.V test	
				Stator	<u>500</u> M Ω	<u>500</u> M Ω		
Rotor	<u>500</u> M Ω	<u>500</u> M Ω						
11. Phase sequence : U.V.W. viewed from D.E $\leftarrow$				Space heater	<u>1000</u> M Ω	<u>1000</u> M Ω		
12. Other data :				<u>ABS</u> <u>2008-08-18</u> <u>I. J. Kim.</u>				
Tested by : <u>2008.08.18</u>								

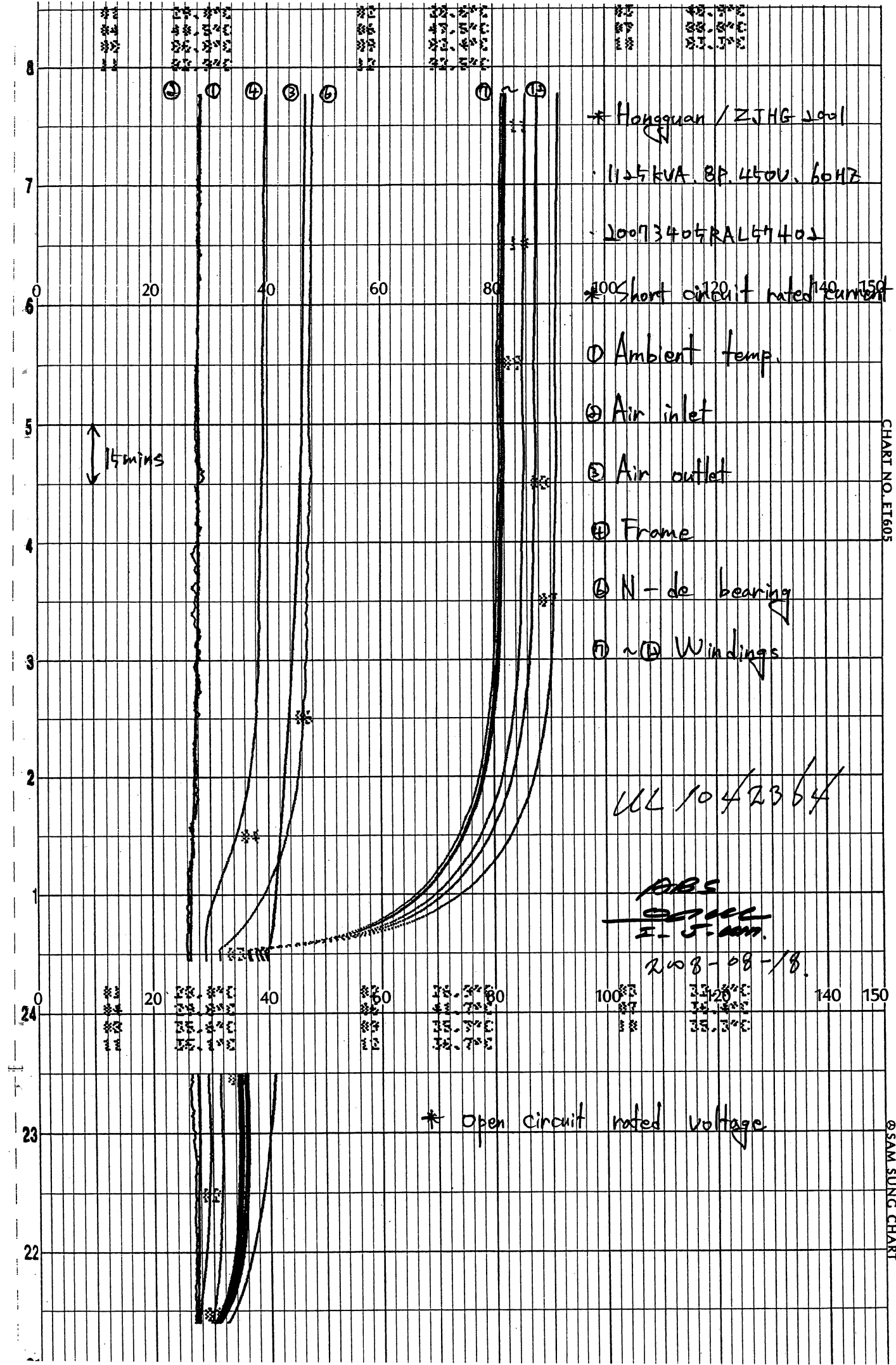


CHART NO. ET605

© SAM SUNG CHART



TEST REPORT OF

~~MOTOR~~
GENERATOR

SHEET NO.

TYPE

HFC7 506-84K

SERIAL NO.

20073405RAL57402

Resistance (Ω)

Time (min)

Stator
~~Rotor~~
(term U-V)

Ambient temp. 29 °C

Cold Resistance 0.005115 Ω

Ambient temp. 28 °C

warm Resistance 0.005220 Ω

Warm Resistance measurement

Time	Resistance (Ω)	Time	Resistance (Ω)
0 : 00		5 : 30	
0 : 30		6 : 00	
1 : 00		6 : 30	
1 : 30	0.005223	7 : 00	
2 : 00	0.005220	7 : 30	
2 : 30	0.005222	8 : 00	
3 : 00	0.005224	8 : 30	
3 : 30		9 : 00	
4 : 00		9 : 30	
4 : 30		10 : 00	
5 : 00		10 : 30	

$$T = \frac{0.005220}{0.005115} (235 + 29) - (235 + 28)$$
$$= 6.4 \text{ K}$$

TEST DATE 2008.08.18

Open circuit rated voltage (Ip23)



TEST REPORT

OF

~~MOTOR~~
GENERATOR

SHEET NO.

TYPE

HFC7 506-84K

SERIAL NO.

20073405RAL57402

Resistance (Ω)

Time (min)

Stator~~Rotor~~

(term U-V)

Ambient temp.

29

 $^{\circ}\text{C}$

Cold

Resistance

0.006115

 Ω

Ambient temp.

29

 $^{\circ}\text{C}$

warm

Resistance

0.006119

 Ω

Warm Resistance measurement

Time	Resistance (Ω)	Time	Resistance (Ω)
0 : 00		5 : 30	
0 : 30		6 : 00	
1 : 00		6 : 30	
1 : 30	0.006151	7 : 00	
2 : 00	0.006119	7 : 30	
2 : 30	0.006091	8 : 00	
3 : 00	0.006066	8 : 30	
3 : 30		9 : 00	
4 : 00		9 : 30	
4 : 30		10 : 00	
5 : 00		10 : 30	

$$T = \frac{0.006119}{0.006115} (235 + 29) - (235 + 29)$$
$$= 41.8 \text{ K}$$

TEST DATE 2008.08.18

short circuit rated current (I_{p23})



TEST REPORT OF ~~MOTOR~~ GENERATOR

SHEET NO.

TYPE

HFC7 506-84K

SERIAL NO.

20073405RAL57402

Resistance (Ω)

Time (min)

~~Stator~~
Rotor
(term U-V)

Ambient temp. 29 °C

Cold Resistance 1.0181 Ω

Ambient temp. 29 °C

warm Resistance 1.1741 Ω Warm Resistance measurement ($\times 0.03$)

Time	Resistance (Ω)	Time	Resistance (Ω)
0 : 00		5 : 30	
0 : 30		6 : 00	
1 : 00		6 : 30	
1 : 30	38.384	7 : 00	
2 : 00	38.137	7 : 30	
2 : 30	38.979	8 : 00	
3 : 00	38.837	8 : 30	
3 : 30		9 : 00	
4 : 00		9 : 30	
4 : 30		10 : 00	
5 : 00		10 : 30	

$$T = \frac{1.1741}{1.0181} (235 + 29) - (235 + 29) \\ = 40.4 \text{ K}$$

TEST DATE 2008.08.18

Short circuit rated current (I_{sc})

Calculation for Equivalent temperature rise

Type : HFC7 506-84K

Ser. No. 20073405RAL57402

Rating : 1125 KVA , 8 Poles , 450 V , 60 HZ

SHORT CIRCUIT WITHOUT COOLER (IP:23) (LOAD CONDITION)

1. Cold condition winding resistance

cooling air(tc)	29 deg.C
stator (ra)	0.005115 Ohms
rotor (rf)	1.0181 Ohms

2. Temperature test at no load rated voltage

cooling air(tci)	28 deg.C
stator (rai)	0.00522 Ohms
stator temperature rise (tai)	6.4 K

3. Temperature test at short circuit rated current

cooling air(tcc)	29 deg.C
stator (rac)	0.006119 Ohms
rotor (rfc)	1.1741 Ohms
exciter current (ifk)	3.94 A
stator temperature rise (tac)	51.8 K
rotor temperature rise (tfc)	40.4 K

4. Temperature rise at rated load

rated field current (ifn)	5.39 A
temperature rise(stator) (tan)	58.2 K
temperature rise(rotor) (tfn)	75.6 K

where $(tan) = (tai) + (tac)$
 $(tfn) = (tfc) * (ifn)^2 / (ifk)^2$



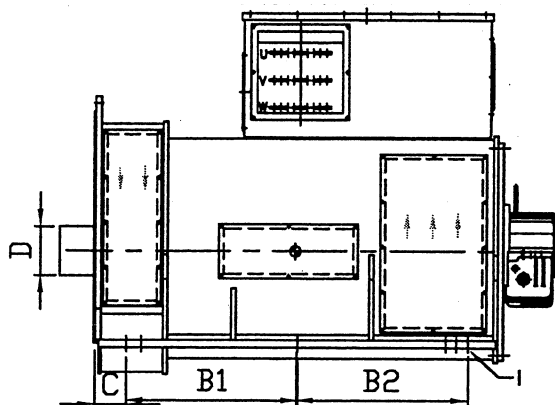
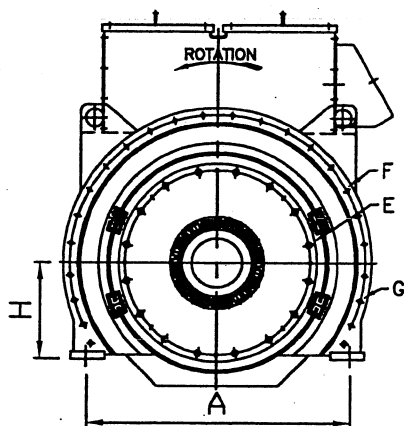
INSPECTION REPORT

검사 성적서

CHECKED BY :
검 토 자

PROJ. NO. 수주번호	20073405RAL574	SPEC 용량, 형식	900KW, 8P, 450V	INSP. DATE 검 사 일	2008.08.17
CUSTOMER 수 주 처	Hongguan	DWG. NO. 도면번호	3H-000019	INSPECTOR 검 사 자	S.K.SEOK
PROJ. NAME 수 주 명	ZJHGG2001	Q'TY 수 량	3SET(NO: 2)	SERIAL NO. 일련번호	✕

FINAL CHECK SHEET(D)

# DIMENSION #
(치 수)

PART (구분)	MK (기호)	A	B1	B2	C	D	E	F	G	H	I	
SPEC(치수)		±1.5 1170	±1.0 705	±1.0 705	±0.5 110	±0.2 ∅218	16-∅26	16-M16	8-M20	-8.2 430	6-∅39	
MEASURE(측정)		+0.1	+0.1	+0.1	-0.4	+0.1	16-∅26	16-M16	8-M20	-0.11	6-∅39	

(검 사 표)

NO. (번호)	ITEM (항목)	STD&DWG (도면)	CHECK (검사)	RESULT (결과)	REMARK (비고)
1	POSITION OF TERMINAL BOX 단자함 위치	APPROVAL SPEC	G	G	
2	CABLE GLAND SIZE & ARRANGE CONDITION 인출부 치수 및 나열상태	APPROVAL SPEC	G	G	
3	BEARING CONDITION 베어링 상태	APPROVAL SPEC	G	G	
4	COVER ASSEMBLY CONDITION 카바 조립 상태	APPROVAL SPEC	G	G	
5	DAMAGE OF EACH PARTS 각 부품의 흠집	APPROVAL SPEC	G	G	

NOTE(특기)

VISUAL INSPECTION : GOOD

유점 참조(계측기 사용 LIST)

G : GOOD NG : NO GOOD NA : NOT APPLICATION
(양호) (불량) (해당없음)

FINAL INSPECTION

최 종 판 정

ACCEPT

TEST REPORT OF GENERATOR

Type: HFC7 506-84K (IP 23) Serial No: 20073405RA159403

R/M TEST SHOP

1. Temperature test: 450 V, 1443.4 A, $\cos \phi = 1$ Field = V A

[illegible]

Temp. run time :		Winding resistance(Ω)		Temp. rise by resistance method(K)		Temp. rise by E.T.D method (K)	Remark
Hr	mins						
Ambient / Coolant temp ($^{\circ}\text{C}$)		Stator (U-V)	Rotor (I-k)	Stator	Rotor		
Cold	28	0.005113	1.0134				
Warm							

2. Over current test : 150 % of rated current (2165.1 A) for 30 secs

3. Over speed test : 120 % of synch. speed (1080 rpm) for 120 secs

4. Open circuit characteristic test

5. Short circuit, characteristic test

[illegible]

6. Load test at $\cos \phi =$

				Voltage(V)	Current(A)	%	Remark
				450	0	0%	
				446.2	721	50%	
				437.2	1443	100%	

7. Phase Voltage Comparison : $U - V = 450$ V, $V - W = 450$ V, $W - U = 450$ V

8. Exciter data : U = 63, S = 40, T = 55, K = 20, R47 = 10, R1 =

Rectifier Transformer(T6) : 5.5.5 / 5.4.5 Current transformer(T1,T2,T3) : 2.1 - 2.6

Reactor(L1) : 41-42 2.0mm Capacitor(C1) : 143 Thyristor controller(R2) :

Adjustment : $U_{soll} =$

$$V_R =$$
$$T_N =$$

Others :

9. High voltage test : space heater: 1500 [V]

Stator = AC $\downarrow$ 400 V for 60 secs

Rotor = AC 1500 V for 60 secs

10. Insulation resistance

	Before H.V test	After H.V test
Stator	500 MΩ	500 MΩ
Rotor	500 MΩ	500 MΩ
Space heater	1000 MΩ	1000 MΩ

11. Phase sequence : U.V.W. viewed from D.E $\leftarrow$

12. Other data :

Tested by : Joo B. B. 13

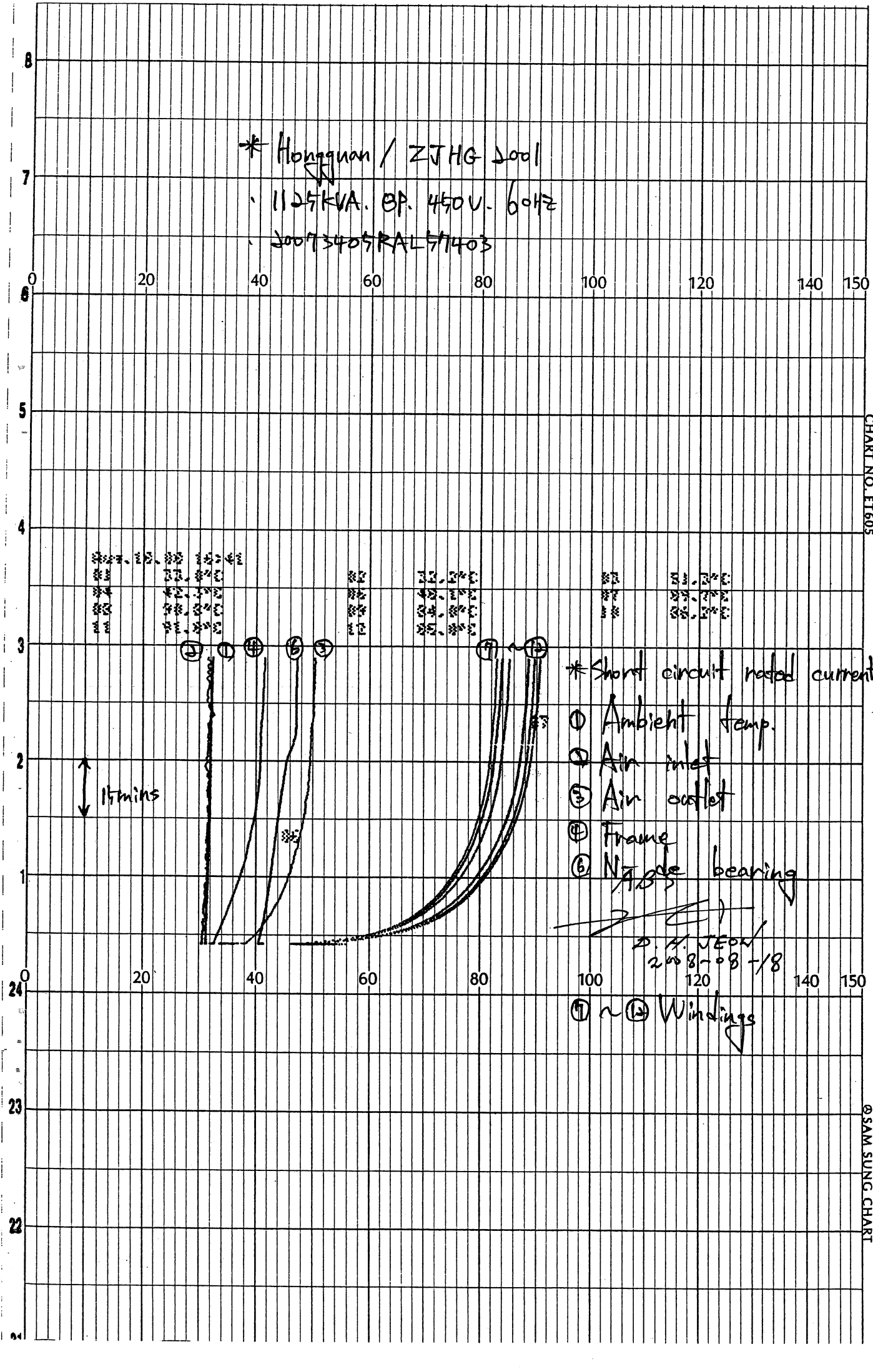
ABS

D. H. JEON
2008-08-19

* Hongguan / ZJHG 2001
 1125KVA. BP. 440V. 60Hz
 20073405RAL571403

CHART NO. ET1605

©SAM SUNG CHART





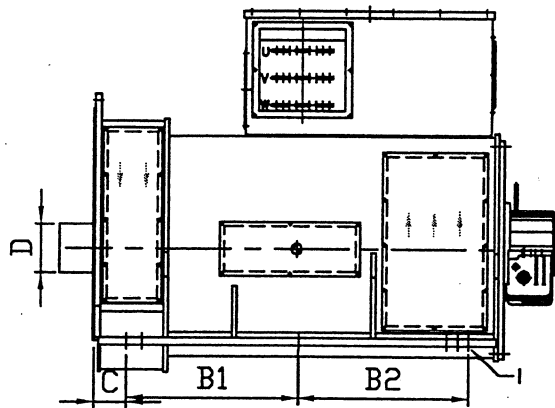
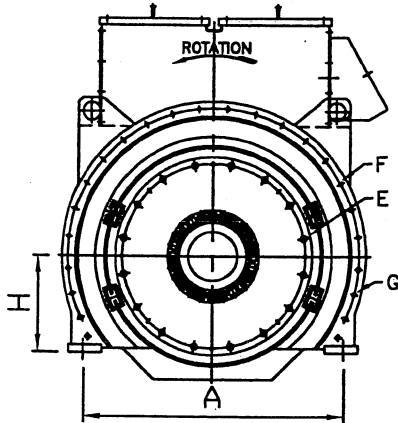
INSPECTION REPORT

검사 성적서

CHECKED BY :
검 토 자

PROJ. NO. 수주번호	20073405RAL574	SPEC 용량, 형식	900KW, 8P, 450V	INSP. DATE 검 사 일	2008.08.17
CUSTOMER 수 주 처	Hongguan	DWG. NO. 도면번호	3H-000019	INSPECTOR 검 사 자	S.K.SEOK
PROJ.NAME 수 주 명	ZJHGG2001	Q'TY 수 량	3SET(NO: 3)	SERIAL NO. 일련번호	✕

FINAL CHECK SHEET(D)

# DIMENSION #
(치 수)

PART (구분)	MK (기호)	A	B1	B2	C	D	E	F	G	H	I	
SPEC(치수)		±1.5 1170	±1.0 705	±1.0 705	±0.5 110	±0.2 ∅218	16-∅26	16-M16	8-M20	-8.2 430	6-∅39	
MEASURE(측정)		+0.1	+0.1	+0.1	-0.4	+0.1	16-∅26	16-M16	8-M20	-0.10	6-∅39	

(검 사 표)

NO. (번호)	ITEM (항목)	STD&DWG (도면)	CHECK (검사)	RESULT (결과)	REMARK (비고)
1	POSITION OF TERMINAL BOX 단자함 위치	APPROVAL SPEC	G	G	
2	CABLE GLAND SIZE & ARRANGE CONDITION 인출부 치수 및 나열상태	APPROVAL SPEC	G	G	
3	BEARING CONDITION 베어링 상태	APPROVAL SPEC	G	G	
4	COVER ASSEMBLY CONDITION 카바 조립 상태	APPROVAL SPEC	G	G	
5	DAMAGE OF EACH PARTS 각 부품의 흠집	APPROVAL SPEC	G	G	

NOTE(특기)

VISUAL INSPECTION : GOOD

유침 참조(계측기 사용 LIST)

G : GOOD NG : NO GOOD NA : NOT APPLICATION
(양호) (불량) (해당없음)

FINAL INSPECTION

최 종 판 정

ACCEPT



INSPECTION REPORT

검사 성적서

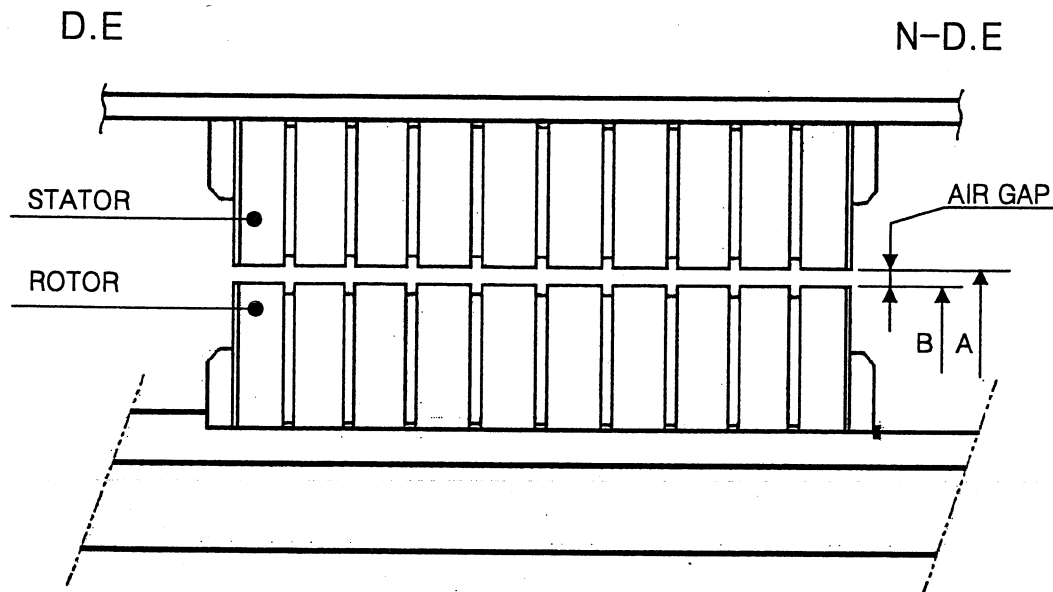
CHECKED BY.

검토자.



PROJ. NO 수주번호	20073405RAL574	SPEC. 용량.형식	900KW.8P.450V	INSP. DATE 검사일	2008.08.17
CUSTOMER 수주처	HONGGUAN	DWG. NO 도면번호	✕	INSPECTOR 검사자	박국철
PROJ. NAME 수주명	ZJHG2001	QUANTITY 수량	3 SET	SERIAL NO 일련번호	✕

DIMENSION CHECK SHEET(AIR GAP)



MK SPEC CHECK (제품 NO)	MASURING POINT		AIR GAP(±10%)	REMARK
	A	B		
	Φ 601	Φ 597	2.0mm(±0.2)	
NO.1	Φ 601.032	Φ 597.02	2.006	
NO.2	Φ 601.065	Φ 597.03	2.017	
NO.3	Φ 601.032	Φ 597.03	2.001	

주) A,B CHECK값은 DE,N-DE측 X,Y값의 평균값임.

NOTE.

G : GOOD

NG : NOT GOOD

NA : NOT APPLICABLE

FINAL DECISION

양 호

불 량

해 당 없 음

최 종 판 정



Operating Instructions Synchronous Generator

Common items | Instruction Manual

Operating Instructions Synchronous Generator



CAUTION

The information contained in this book is intended to assist operating personnel by providing information on the general characteristics of the purchased equipment. IT DOES NOT relieve the user of the responsibility of using accepted engineering practices in the installation, operation and maintenance of this equipment.

Contents

1. Construction of Brushless A.C Generator	3
1.1 Component	
1.2 General	
1.3 Composition	
2. Excitation System (Operation)	15
2.1 Mode of Operation (SPRESY 15)	
2.2 Operation (SPRESY 15)	
2.3 Maintenance (SPRESY 15)	
2.4 Mode of Operation (6 GA 2491)	
2.5 Operation (6 GA 2491)	
2.6 Maintenance (6 GA 2491)	
3. Maintenance	26
3.1 Installation & Inspection Check List	
3.2 Flange-Type Sleeve Bearing (for ring lubrication system)	
3.3 Flange-Type Sleeve Bearing (forced lubrication system)	
3.4 Rolling-Contact Bearings (series 02 and 03)	
3.5 Coupling A-Type (single-bearing generators with flanged shaft and one-part fan wheel)	
3.6 Coupling B-Type (single-bearing generators with lamination plate)	
3.7 Coupling (double bearing generator)	
3.8 Air Filters	
3.9 Terminal Box	
3.10 Disassembly of A.C. Generator (Fig. 39, 40 and 41)	
3.11 Cooler	
3.12 Cooling-Water Failure Emergency Operation	
4. Trouble Shooting	49
4.1 Excitation Part for SPRESY 15	
4.2 Excitation Part for 6 GA 2491	
4.3 Main Machines and Exciters (HF. 5 and 6)	
4.4 Bearing Part	
4.5 Operating Procedure & Check Sheet for Trouble Shooting	

Safety Notes

The warnings «DANGER, WARNING, CAUTION, NOTICE, NOTE» are used to draw the user's attention different points:

DANGER

This warning is used when an operation, procedure, or use may cause personal injury or loss of life.

WARNING

This Warning is used when an operation, procedure, or use may cause a latently dangerous state of personal injury or loss of life.

CAUTION

This warning is used when an operation, procedure, or use may cause damage to or destruction of equipment and a slight or serious injury.

NOTICE

This warning is used when an operation, procedure, or use may cause damage to or destruction of equipment.

NOTE

This warning is used when an operation, procedure, or delicate installation requires clarification.

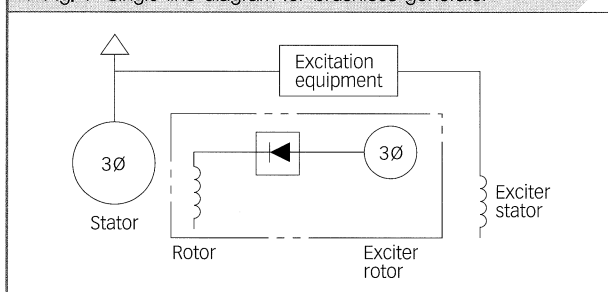
1.1 Component

The brushless A.C. generators, as shown in Figs. 8, 9, 10 and 11, (drip-proof type, totally-enclosed internal-cooling type) are composed of

- ① a synchronous generator
- ② an A.C. exciter
- ③ a Rotary rectifier
- ④ static excitation devices.

The brushless generator, as shown in Figs. 8, 9, 10 and 11, has the exciter and the rotary rectifier mounted on the generator's rotor shaft. The three-phase output of the A.C. exciter is rectified to D.C. by means of the rotary rectifier, thus enabling the exciting current to be supplied, not through sliding parts, but directly to the field coil of the generator.

⇒ Fig. 1 Single line diagram for brushless generator



1.2 General

1) Type definition

The supply scope of the machine designs available is determined entirely by the data given in the catalogs or offers. The machines of basic design are open-circuit cooled, brushless, low-voltage, synchronous machines with top-mounted excitation control unit.

The machines have a shaft-mounted exciter on the inboard side of the non-drive endshield. The three-phase AC they generate is rectified and fed to the rotor winding of the main machine.

The excitation current required for the shaft-mounted exciter is provided by the main machine via an excitation control unit placed in the top mounted housing, and via a thyristor voltage regulator.

For further information, see the supplementary instructions entitled THYRIPART excitation system on pages 15-25.

Depending on the application, the machines may also be designed in accordance with the type variant defined in the table 1-1.

⇒ Table 1-1. Type definition

Type	Type of construction
HFJ 5, 6, 7	Machines with closed-circuit cooling and air-to water cooler with provisions for emergency operation in case of cooling water failure
HFC 5, 6, 7	Machines with open-circuit cooling and air-to air
HSJ 7	Medium & high voltage machines with closed-circuit cooling and air-to water cooler with provisions for emergency operation in case of cooling water failure
HSR 7	Medium & high voltage machines with open-circuit cooling and air-to air

2) Specification & regulation

The machines comply with the applicable DIN standards and with the requirements of VDE 0530.

They may have been adapted to different classification requirements and foreign standards and regulations.

Unless otherwise stated, the rated output for continuous operation applies to a frequency of 50 Hz, a cooling-air temperature of 40°C and a site altitude of up to 1000 m above sea level.

3) Degree of protection

The DIN 40050 or IEC 34-5 degree of protection of basic design machines is IP 23. Such machines are suitable for operation indoors and may be provided with filters or with pipe connections.

Closed-circuit cooled machines comply with degree of protection IP44 and IP54.

The degree of protection of the machine supplied is shown in the dimension drawing.

4) Type of construction

The machines are normally provided with two bearings (DIN 42950 types of construction B3 or B20) or with one bearing (DIN 42950 types of construction B2 or B16).

The type of construction of the machine supplied is shown in the dimension drawing.

5) Cooling and ventilation

The basic design machines use self-ventilation by a shaft-mounted internal fan at the drive-end.

Cooling air enters the top housing (at the non-drive-end) and cools the excitation control unit and, subsequently, the windings and core packs of the exciter and of the main machine before leaving the top housing at the drive-end.

On machines provided with air filters at the air inlet, the cleaning condition of the filter should be monitored.

In machines having closed-circuit cooling, the air-to-water cooler is placed transversely in the top-mounted box in transverse arrangement, in front of the excitation control unit.

The primary cooling air circulated by the internal fan is re-cooled in the cooler and passed through the excitation control unit, the exciter, and the main machine.

Given the necessary provisions, the machine can be adapted for emergency operation with open-circuit cooling in case of cooling water failure. See pages 46-48.

6) Connecting up

Check the system voltage against the data given on the rating plate. Select the size of the supply cables to match the particular current rating.

Connect the machines in accordance with the diagram in the working drawing.

Before closing the terminal box, check to see that

- Its interior is clean and free from any cable chippings
- All terminal screws or bolts are tight
- The minimum clearances in air are maintained (>10 mm for 500 V, >14 mm for 1 kV and >60 mm for 6 kV; check for any projecting wire ends)
- Entry openings not in use are closed off by firmly screwed-in plugs
- For maintaining the particular degree of protection all sealing surfaces of the terminal box are in order.
The surfaces of metal-to-metal sealing joints must be cleaned and thinly regreased.

Before starting a machine and during operation make sure that all relevant safety regulations are complied with.

7) Insulation testing



DANGER

Hazardous voltage

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

Before commissioning and after long periods of storage or standstill the insulation resistance of the windings to the frame must be measured with D.C. voltage.

Do not discontinue measurement before the final resistance value is indicated (with high-voltage machines, this process may take up to 1 minute).

The limit values for minimum insulation resistance and critical insulation resistance (for measurement at a winding temperature of 25°C) and for measuring voltage can be derived from the following table depending on the rated voltage for the machine.

⇒ Table 1-2. Insulation testing

	Limit values at rated voltage	
	Rated voltage < 2 kV	Rated voltage > 2 kV
Measuring voltage	500 V DC (min. 100 V DC)	500 V DC (max. 1000 V DC)
Minimum insulation resistance with new machine. Cleaned or repaired windings	10 MΩ	100 MΩ
Critical specific insulation resistance after long period of operation	0.5 MΩ/kV	5 MΩ/kV

Dried windings have insulation resistance values between 100 MΩ and 2000 MΩ or higher.

If the insulation resistance value is in the region of the minimum value, dampness and/or dirt could be the cause. If the insulation resistance value falls below this minimum figure, the cause must be established and the winding dried.

In case of drying by warm air oven.

- Remove bearing housings
- Remove rotor
- Remove diode & varistor from excitation equipment part

Bake in oven at temperatures per below table.

The heat should be applied slowly so the desired temperature will not be obtained in less than six hours. Insulation resistance should be measured before the heat is applied, and every six to eight hours thereafter.

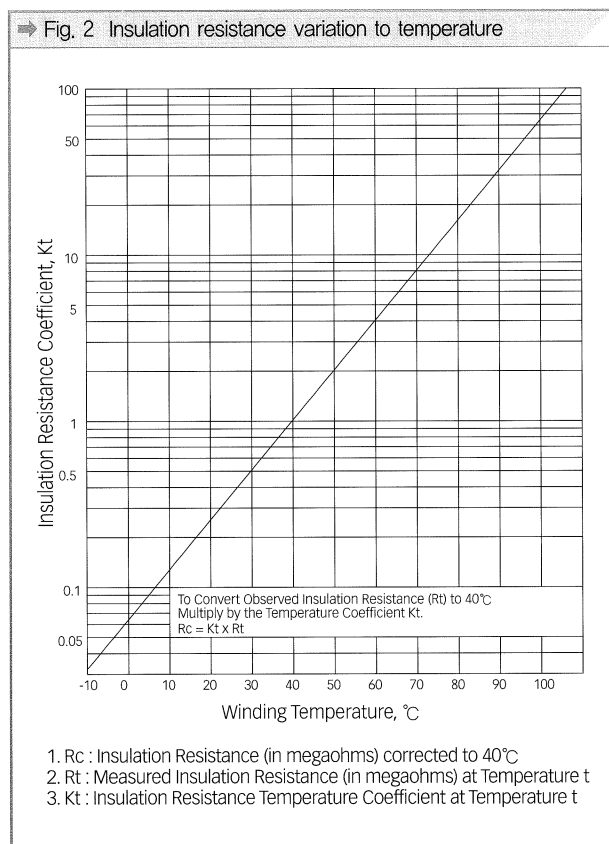
⇒ Table 1-3. Insulation drying temperatures

Class "B"	Class "F"	Class "H"
200° F 94° C	245° F* 118° C	275° F* 135° C

* Class "F" and "H" insulated units should be baked at 70% specified temperature (to avoid steam inside winding) for about six hours, before temperature is raised to drying temperature.

The insulation resistance for clean windings is largely dependent on temperature: for each 10K rise in temperature it falls by half, i.e. with a temperature rise of 50K (e.g. from 25°C to 75°C) it falls to about 1/30 of the initial value.

Insulation resistance variation to temperature can be referred to IEEE 43 as shown on fig. 2.



During operation the insulation resistance of the windings may decrease as result of environmental and operating conditions.

The critical value of the insulation resistance at a winding temperature of 25°C can be calculated depending on the rated voltage by multiplying the latter (kV) by the specific critical resistance value in the table (M Ω /kV).

For example: critical resistance for rated voltage

$$660 \text{ V: } 0.66 \text{ kV} \times 0.5 \text{ M}\Omega/\text{kV} = 0.33 \text{ M}\Omega$$

If the measured insulation resistance value is above the calculated critical figure during operation, the machine can still operate further.

When the measured value reaches or falls below this critical insulation resistance figure, however, the windings must either be dried, or the rotor must be removed and the windings thoroughly cleaned and dried.

If the measured value approaches the critical value, the resistance should subsequently be checked at appropriate short intervals.

Insulation resistance measurements on low-voltage machines with a measuring voltage of 1000 V are only permissible if the insulation resistance has previously been measured with a measuring voltage of a maximum of 500 V and has not fallen below the permitted values.

8) Noise emission

The noise level of the generator will not exceed that specified in Part 9. VDE 0530 (1981).

9) Vibration stability

Reciprocating engines used as prime mover impress vibrations on the alternator because of the pulsating torque output.

Permissible vibration stress measured at the bearing is:

< 10 Hz	vibration amplitude	S	< 0.40 mm-peak
10-100 Hz	vibration velocity	V_{eff}	< 18 mm/s-rms
> 100 Hz	acceleration	b	< 1.6 g

Please inquire if a higher vibration stress level is expected.

10) Transport

WARNING

Improper handling can cause severe injury or property damage.

When lifting generator,

1. Lift only at designated locations.
2. Use spreader for lifting.
3. Apply tension gradually to slings.
4. Do not jerk or attempt to move unit suddenly.
5. Do not use cover lugs when lifting.

The rotor of machines with cylindrical roller bearings, angular-contact ball bearings, or double sleeve bearing are locked in position for transport by a shaft block to protect the bearings.

Do not remove this block until the transmission element is fitted.

Should the machine have to be transported after the transmission element is fitted, other suitable measures have to be taken.

If the machine is not put into service immediately after arrival, store it in a dry, vibration-free room.

11) Storage

WARNING

Can cause severe injury or property damage.

When lifting generator,

1. Lift only at designated locations.
2. Use spreader for lifting.
3. Apply tension gradually to slings.
4. Do not jerk or attempt to move unit suddenly.
5. Do not use cover lugs when lifting.

The location for storage should be dry and clean. There should be no heat that could attack the winding. The machined surfaces (coupling part, foots part, etc.) are coated with rust-resistant grease.

If the coating is broken, immediately remove the rust or moisture and recoat with grease for rust prevention.

If the machine is to be stored for some time, apply all openings with waterproof paper, wooden, or metallic covers.

It is necessary to protect the machine from wind and rain during transportation and storage and to select less humid place for storage.

For storage for a long-term or in the rainy season, it is best to insert heaters to remove moisture or prevent its condensation.

To keep the coil dry, maintain the coil temperature several degrees above room temperature by arranging heaters appropriately under the machine part to warm the coils.

For long time storage, a space heater is placed inside the generator. Its specification is described in the generator final specification and on the nameplate attached to the generator.

12) Installation

NOTE

Experience has shown that any base mounted assemblies of generator and driven units temporarily aligned at the factory, no matter how rugged or deep in section may twist during shipment.

Therefore, alignment must be checked after mounting.

The lubrication measures for normal bearings to be carried out before or during erection of the machines are specified in the instructions "Rolling Contact Bearings and Sleeve Bearings" on pages from 28-37.

Install the machines so that the cooling air has free access unobstructed.

Warm exhaust air must not be drawn in again.

Louver openings must face downwards to maintain the particular degree protection.

Remove the shaft block (where applicable).

Follow the instructions attached to the shaft extension or shown in the terminal box.

The rotors are normally balanced dynamically by means of a half feather key placed in the shaft extension.

Align the machines carefully and accurately, and balance the elements to be fitted on the shaft to ensure smooth and vibration-free running.

Place shims under the feet of the machines, if necessary, to prevent them from being stressed mechanically.

Transmission elements may be fitted and removed only by means of a suitable tool.

The feather keys in the shaft extensions are only secured to prevent them from falling out during shipment.

A machine must not be commissioned without its transmission element having been fitted.

13) Operation

WARNING

Do not operate equipment beyond design limitations. Can cause personal injury or damage to equipment. Operate in accordance with instructions in the manual and nameplate ratings.

NOTICE

In case of cooling system of IP44 (air to water), check the flow of cooling water for sure before starting. Internal temperature rise may cause fatal damage to the generator.

NOTICE

Before starting, check if the bearing oil is filled to the sufficient oil level.

Covers fitted to prevent access to rotating and current carrying parts or to correct the air flow for better cooling must not be open in operation.

If machine application is abnormal (high temperature, extreme vibration, etc.), consult HHI for special instructions.

14) Maintenance

Before starting any work on a machine, make sure that it has been disconnected from the power supply and that unintentional starting is safely prevented.

Clean the cooling air passages at regular intervals, matching the degree of pollution and using oil-free compressed air, for example.

The inside of totally-enclosed fan-cooled machines need only be cleaned during normal overhauls.

If dust or moisture has penetrated into the terminal compartment, it should be carefully cleaned and dried, in particular the surfaces of the insulating parts. Check the seals and eliminate the leak.

15) Inspection

The first inspection should be carried out after approximately 500 hours.

The following checks should also be carried out:

- Running smoothness of machine satisfactory
- Rotor alignment within tolerances
- No subsidence or cracks in the foundation
- All fixing bolts of mechanical and electrical joints tight
- Insulation resistance of windings satisfactory (compare with previous reading and record)
- No bridging of any bearing insulation

Any excessive deviations or changes ascertained during the checks must be corrected immediately.

Damaged or used locked elements from released bolted joints must be renewed.

The basic intervals between inspections are approximately 4000 hours, 1000 switching operations or 1 year for intermittent operation and approximately 16,000 hours or 2 years for continuous operation, depending on which occurs first.

The cleaning of all parts becoming fouled by the flow of cooling air depends on the intervals decided after the first inspection according to the rate of fouling which occurs locally.

Cleaning should be carried out with dry compressed air. Information on oil changes, regreasing, etc. is given on the lubrication instruction plate on the machine or in the supplementary instructions for bearings.

The checks stated for the first inspection after 500 hours should be performed during these inspections also.

When a machine is dismantled, the following checks should be made:

- Slot wedges in stator and rotor cores tight
- Windings, connection leads, and insulating parts in satisfactory condition with no discoloration

After reassembly, again follow the instructions given for installation.

16) Spare parts

Spare parts shall be normally supplied in accordance with the classification societies requirement.

Independent of the classification societies requirements, we recommend the following sets of spares be ordered with the generators

- 1 set of bearings or bearing shells for sleeve bearing
- 1 set of rotating rectifiers
- 1 set of rectifiers for the constant-voltage unit
- 1 regulator (AVR)

1.3 Composition

1) Stator frame and winding

The stator frame is of welded design.

The stator core is centred in the frame and locked against rotation and shifting.

The stator winding is of a two-layer coil design with insulation class F.

This insulation is made in a special way and is comprised of integrated-mica & enamel coated insulating material impregnated with cast resin.

It is characterized by high dielectric strength, resistance to moisture, aggressive gases and vapours, as well as rigidity and long life.

2) Rotor and windings

The shaft for machines construction type B3 and B20 is designed with a normal cylindrical shaft extension for two bearings. In the case of types B2 and B16, the shaft is fitted with a flange.

The rotor core of the main machine is mounted on the shaft, tensioned axially, and supports the field and damper windings. The damper winding bars lie in the slots of the rotor core and are welded to the rings.

The rotor core of the exciter is mounted on the shaft and supports the three-phase exciter winding.

The rectifier supporting wheel is mounted on the shaft between the two laminated cores.

The rotor is balanced dynamically.

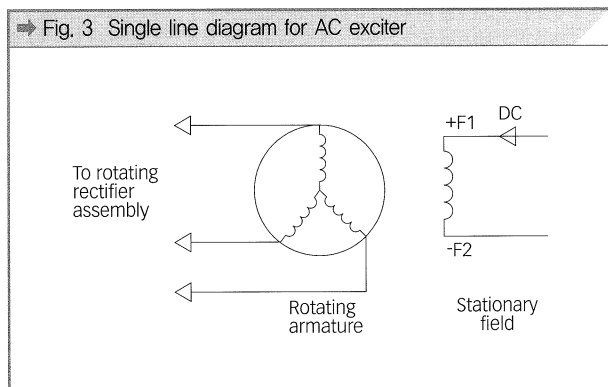
3) AC exciter

The AC exciter is composed for revolving-armature type, three-phase, synchronous generators.

In revolving-armature type generators, unlike ordinary ones, the stator and rotor are in reverse relation.

The armature is installed at the shaft end on the non-connection side where AC power is generated, and the output of the static excitation device for control is connected to the field winding installed on the fixed side as shown in Fig. 3.

⇒ Fig. 3 Single line diagram for AC exciter



4) Rotating rectifier

The rotating rectifier is a silicon rectifier which is connected so as to compose a three-phase full-wave rectification circuit as shown in Fig. 4 and is mounted on the rotor shaft of generator in Fig. 9-1.

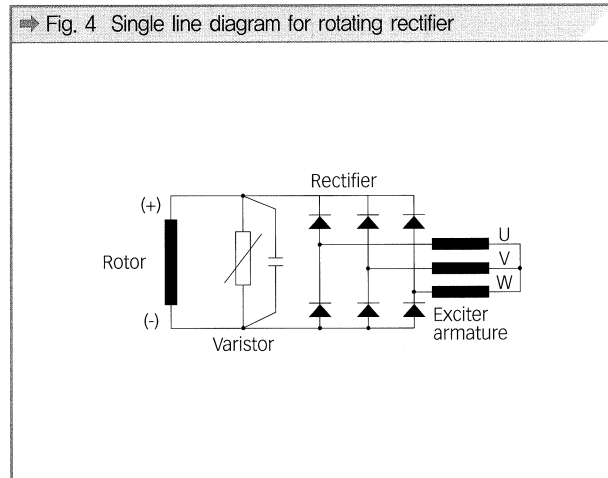
- The mounting screws are between 4.5 Nm and 5.5 Nm
- The contact screws are between 2.5 Nm and 3.5 Nm



CAUTION

Fastening screws for the rotating diodes must be tightened with the recommended torque.

⇒ Fig. 4 Single line diagram for rotating rectifier



5) Excitation system

The combination of an excitation unit with a thyrist and voltage regulator is called a THYRIPART-excitation system. The excitation unit supplies a load-dependent field current slightly higher than would be required for producing the rated voltage.

The regulator variably reduces the field current as necessary to obtain constant alternator voltage. This method of load-dependent excitation (compounding) results in excellent dynamic response to load switching applications and short-circuits.

A block diagram is shown in Figs. 15, 19, 20 & 21.

6) Shaft

Concerning the generator shaft, the ship's classification certified forged steel should be applied and designed with ample strength for coupling with the prime mover.

7) Bearing

Depending on the design and the operating conditions specified in the order, the machines are fitted with grease-lubricated rolling-contact bearings or with sleeve bearings with or without forced-oil lubrication.

For a full description and special instructions, reference should be made to the supplementary instructions.

8) Cooling fan

To let the required amount of cooling air pass through, a fan of either cast iron or welded steel plate construction is provided.

Concerning the site of its installation, in either case, it is to be arranged on the prime mover's side of the generator.

It is a one-way ventilating system which takes in air from the opposite side of the prime mover and lets out exhaust air at the prime mover's side.

We have taken into consideration that the engine's oil vapor should not be sucked into the machine.

9) End shield Drive-end/Non-drive-end

Both end shields are designed as flat plates and can take either a bearing or a shaft extension in accordance with the particular type of machine construction.

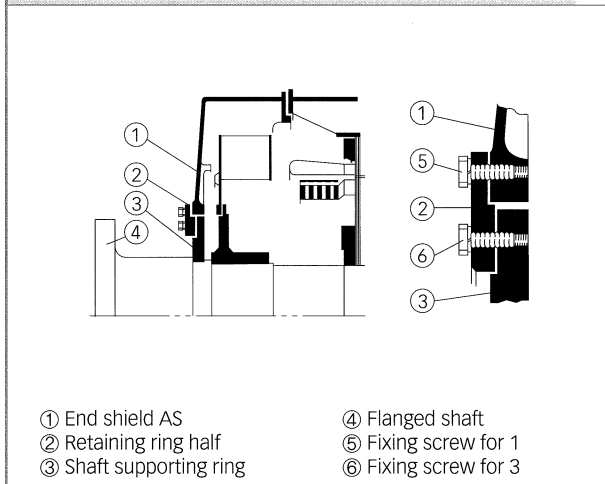
The exciter yoke ring in which the exciter poles are bolted in regular distribution, is welded to the non-drive-end shield.

10) Rotor locking device

The following instructions supplementing and modifying the basic operating instructions apply to single bearing generators of type of construction B2 or B16 which are coupled with diesel engines or turbines.

See the instruction manual on pages 38-39.

⇒ Fig. 5 Rotor locking device



11) Insulation for the prevention of shaft current (high voltage and large machines)

NOTE

Insulated Bearing

Any connection to this bearing must be insulated from it to prevent bearing current.

To prevent the shaft current caused by the unbalance of magnetic resistance of magnetic circuits, the insulator is provided at the non-drive-end shield as shown in Fig. 6. The shaft voltage is a high-frequency voltage of usually 1 volt or less and rarely several volts.

When a shaft current flows, by this voltage the shaft and journal part are tarnished. In the worst condition, sparking results in minute black spots.

There is a possibility that the oil film is broken locally, developing burn-out trouble. When disassembling or assembling, be sure to measure the insulation resistance.

The value of 1 to 3 $k\Omega$ will be satisfactory. It is generally said that shaft voltage for bearings is limited as follows.

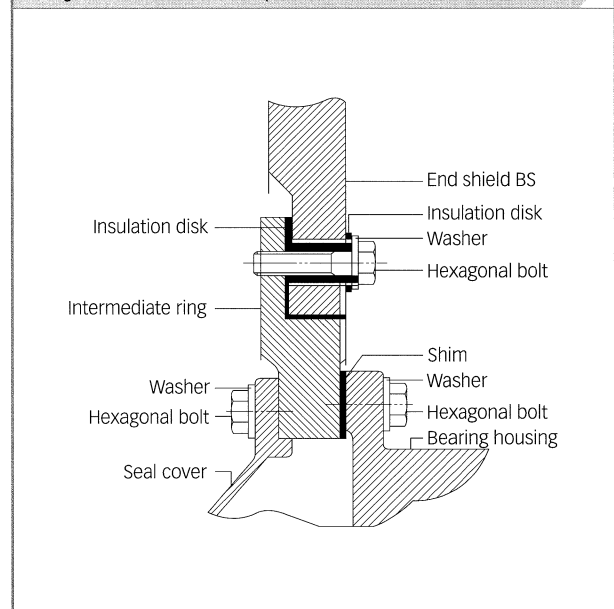
<500 mV

Harmless.

500 to 1,000 mV A detrimental shaft current may possibly flow.

>1,000 mV Bearings may be damaged in a week to a year (unless insulation is provided).

⇒ Fig. 6 Insulation for the prevention of shaft current



12) Thermometer

For checking the bearing temperature, a thermometer is provided for each bearing.

13) Space heater

⚠ DANGER

Hazardous voltage

Will cause death, serious injury, electrocution or property damage.

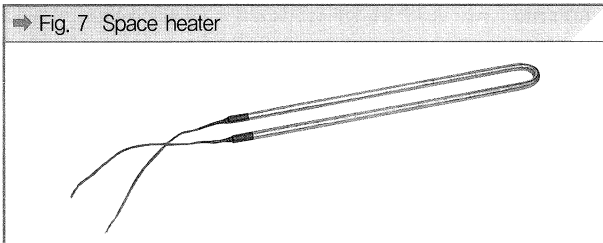
Disconnect all power before working on this equipment.

In order to prevent the accumulation of moisture and condensation while the generator is idle, space heaters are provided within the stator frame.

The space heaters can be easily removed from outside the enclosure.

The heater is comprised of stainless-sheathed nichrome, filled with insulators in the sheath and is U-shaped as shown in Fig. 7.

⇒ Fig. 7 Space heater

**14) Air/water cooler**

If required, HFC 5, 6, 7 and HSR 7 alternators can be supplied with a top-fitted air/water cooler as special requirement.

The cooler can be used for either fresh water or sea water with double tubes applied.

The type designation for the generators are is changed from HFC to HFJ, or from HSR to HSJ.

Due to the closed-circuit cooling system the degree of protection has been upgraded from IP 23 to IP 44 and IP 54.

The electrical version of the generator remains unchanged.

The generators HFJ and HSJ can easily be converted for emergency operation as an open-circuit aircooled machine if the coolant system or the cooling element fails.

In this case, the degree of protection is IP 23 with the rated output as shown on pages 46-48.

Please provide the following information with any inquiry:

- Alternate rated output
- Classification society
- Coolant temperature (air)
- Cooling water inlet temperature
- Fresh water or sea water

15) Terminal box**Hazardous voltage**

Will cause death, serious injury, electrocution or property damage.

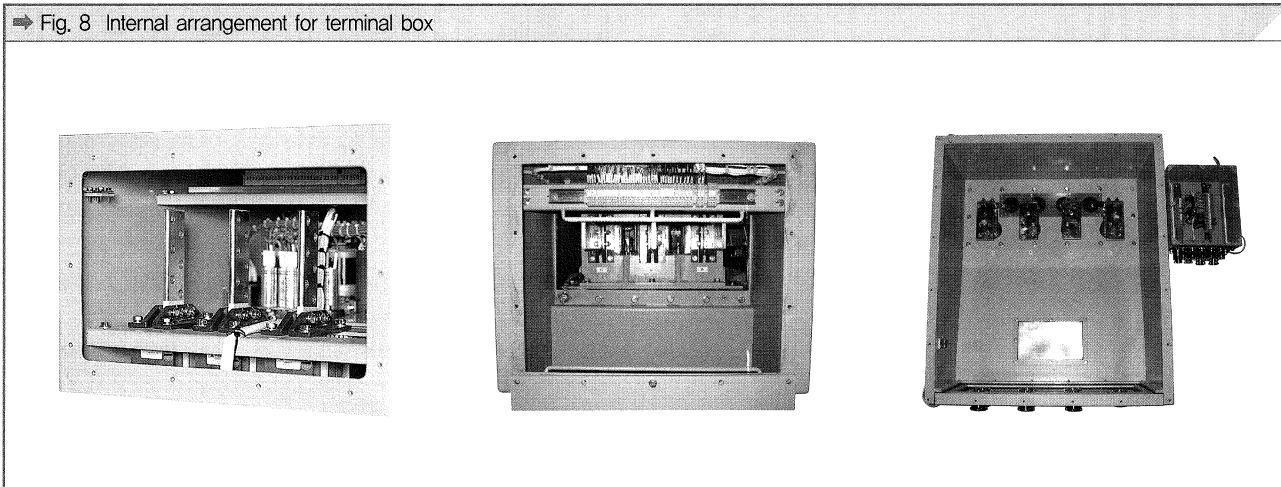
Disconnect all power before working on this equipment.

Cable entry to the 3 main connections, (U.V.W.) and to the 2 field terminals +F1, -F2 can be from the left or right, as required.

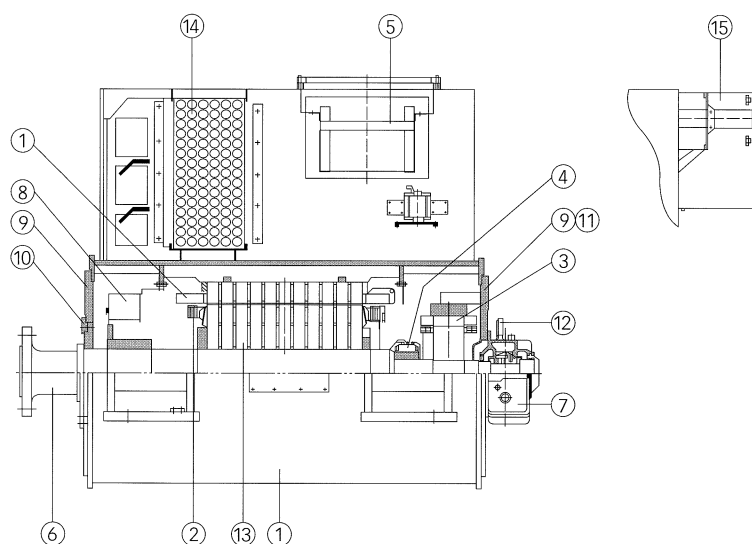
The cable entry plates are supplied undrilled or drilled with cable gland as required.

See Fig. 8.

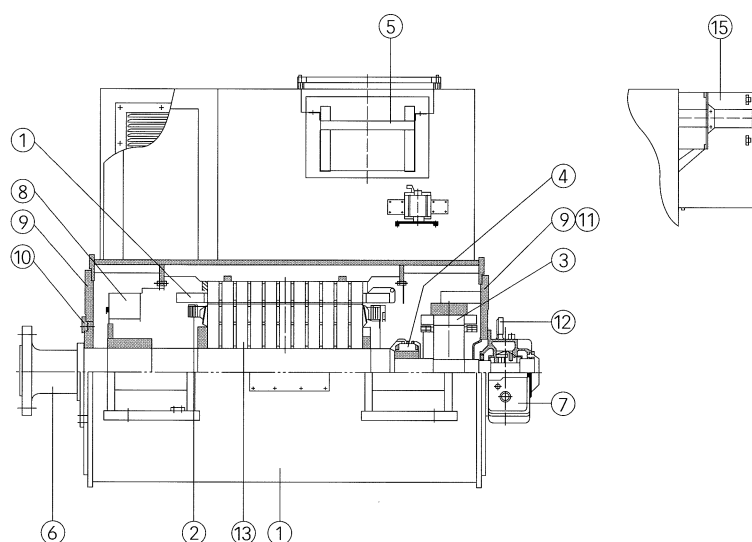
⇒ Fig. 8 Internal arrangement for terminal box



⇒ Fig. 9 Sectional drawing for HF. 5, 7 & HS. 7 type generator (single sleeve bearing)



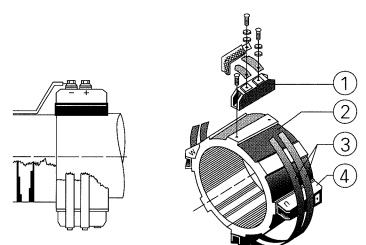
HFJ 5, 7 & HSJ 7 (air to water cooling)



HFC 5, 7 & HSR 7 (air to air cooling)

- ① Stator and stator windings assembly
- ② Rotor and windings assembly
- ③ A.C exciter assembly
- ④ Rectifier assembly (Fig. 9-1)
- ⑤ Excitation equipment
- ⑥ Shaft
- ⑦ Bearing
- ⑧ Cooling fan
- ⑨ End shield DE/N-DE
- ⑩ Rotor lockage device
- ⑪ Insulation for prevention of shaft current (Fig. 6)
- ⑫ Thermometer
- ⑬ Space heater
- ⑭ Cooler
- ⑮ Terminal box

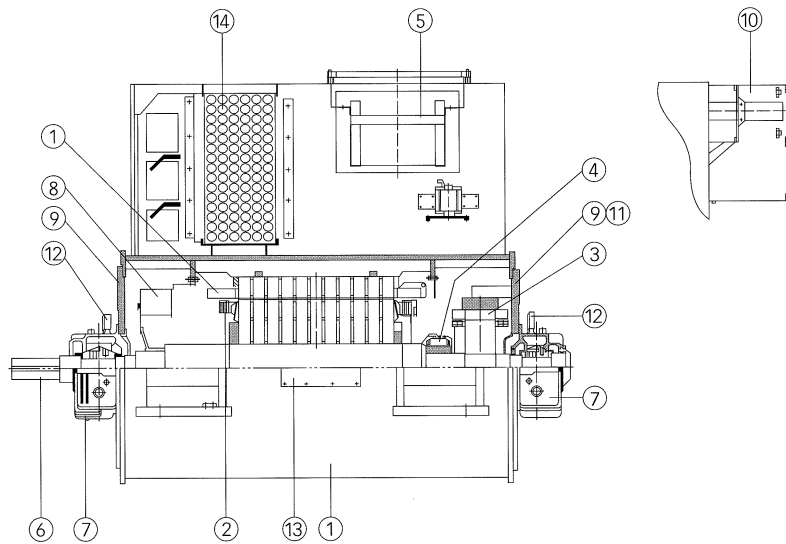
⇒ Fig. 9-1 Rectifier assembly



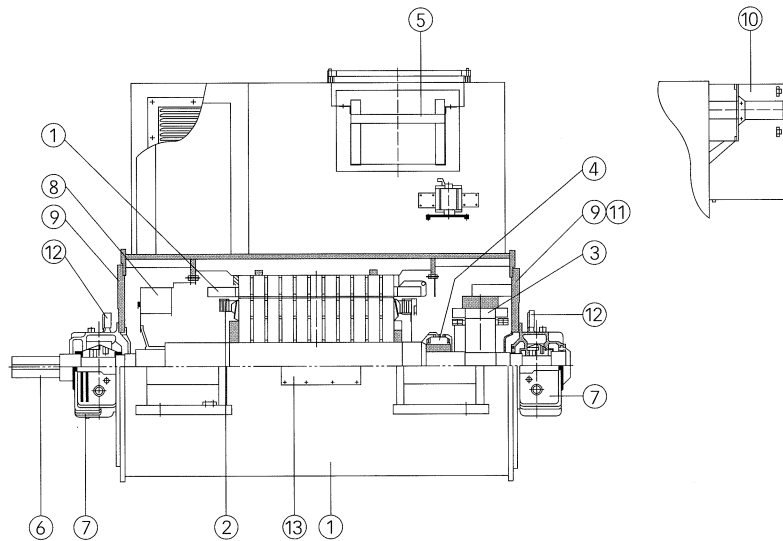
- ① Varistor module
- ② Hub

- ③ Connector rings
- ④ Rectifier module

⇒ Fig. 10 Sectional drawing for HF. 5, 7 & HS. 7 type generator (double sleeve bearing)



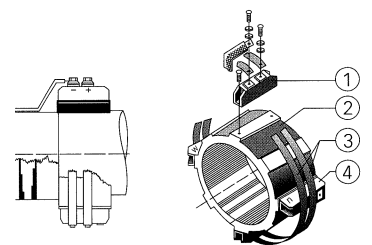
HFJ 5, 7 & HSJ 7 (air to water cooling)



HFC 5, 7 & HSR 7 (air to air cooling)

- ① Stator and stator windings assembly
- ② Rotor and windings assembly
- ③ AC exciter assembly
- ④ Rectifier assembly (Fig. 10-1)
- ⑤ Excitation equipment
- ⑥ Shaft
- ⑦ Bearing
- ⑧ Cooling fan
- ⑨ End shield DE/N-DE
- ⑩ Terminal box
- ⑪ Insulation for prevention of shaft current (Fig. 6)
- ⑫ Thermometer
- ⑬ Space heater
- ⑭ Cooler

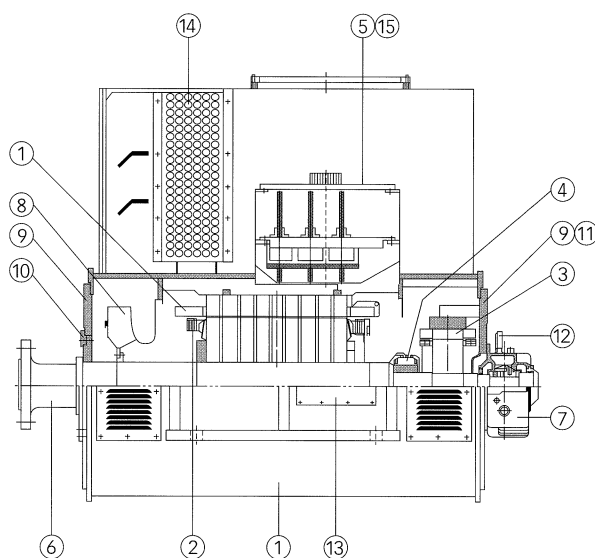
⇒ Fig. 10-1 Rectifier assembly



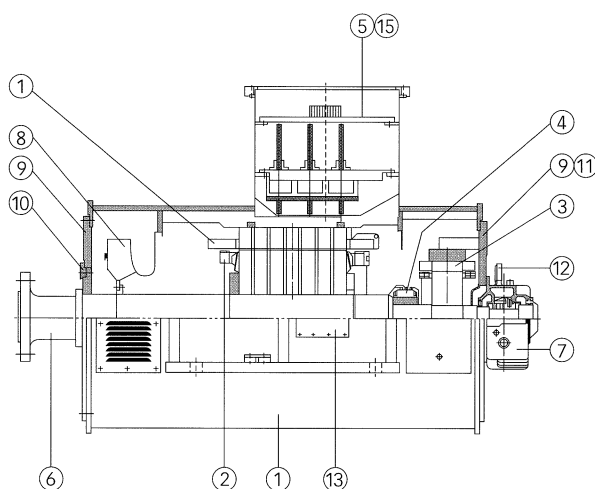
- ① Varistor module
- ② Hub

- ③ Connector rings
- ④ Rectifier module

⇒ Fig. 11 Sectional drawing for HF, 6, 7 & HS, 7 type generator (single sleeve bearing)



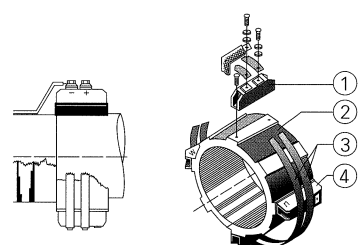
HFJ 6, 7 & HSJ 7 (air to water cooling)



HFC 6, 7 & HSR 7 (air to air cooling)

- ① Stator frame and stator windings assembly
- ② Rotor and windings assembly
- ③ AC exciter assembly
- ④ Rectifier assembly (Fig. 11-1)
- ⑤ Excitation equipment
- ⑥ Shaft
- ⑦ Bearing
- ⑧ Cooling fan
- ⑨ End shield DE/N-DE
- ⑩ Rotor lockage device
- ⑪ Insulation for prevention of shaft current (Fig. 6)
- ⑫ Thermometer
- ⑬ Space heater
- ⑭ Cooler
- ⑮ Terminal box

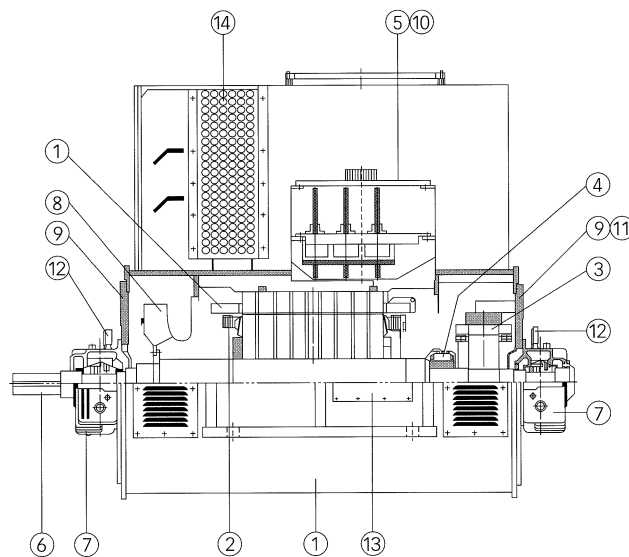
⇒ Fig. 11-1 Rectifier assembly



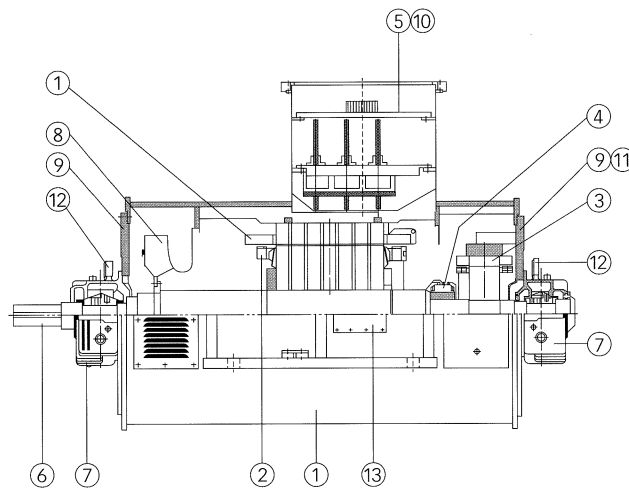
- ① Varistor module
- ② Hub

- ③ Connector rings
- ④ Rectifier module

⇒ Fig. 12 Sectional drawing for HF, 6, 7 & HS, 7 type generator (double sleeve bearing)



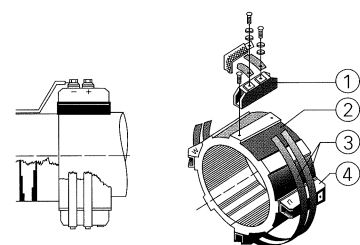
HFJ 6, 7 & HSJ 7 (air to water cooling)



HFC 6, 7 & HSR 7 (air to air cooling)

- ① Stator frame and stator windings assembly
- ② Rotor and windings assembly
- ③ AC exciter assembly
- ④ Rectifier assembly (Fig.12-1)
- ⑤ Excitation equipment
- ⑥ Shaft
- ⑦ Bearing
- ⑧ Cooling fan
- ⑨ End shield DE/N-DE
- ⑩ Terminal box
- ⑪ Insulation for prevention of shaft current (Fig. 6)
- ⑫ Thermometer
- ⑬ Space heater
- ⑭ Cooler

⇒ Fig. 12-1 Rectifier assembly



- ① Varistor module
- ② Hub

- ③ Connector rings
- ④ Rectifier module

2.1 Mode of Operation (SPRESY 15)

1) Description

Brushless synchronous generators consist of the main and exciter machine.

The main machine's field winding is powered from the exciter rotor winding via a rotary, three-phase bridge-connected rectifier set.

The exciter is powered from THYRIPART excitation equipment.

Excitation equipment and thyristor voltage regulator are combined in the THYRIPART excitation system.

The excitation current required is supplied to the main machine via the excitation equipment which is adjusted to deliver a field current resulting in a generator output voltage above the maximum reference value over the entire load range when the voltage controller is inactive.

The actual function of the voltage regulator is to provide a bypass for a variable portion of the current supplied by the excitation equipment for controlling the generator voltage. The thyristor regulator module consists of two assemblies: the regulator module and the firing module with thyristor in buck circuit.

The three-phase generator voltage, having been reduced to 24V by the measuring-circuit transformers, is applied to terminals 17, 18 and 19.

A direct voltage of approx. 30 V (terminal 20 to terminal 13 or 14) is produced at the output of the rectifier bridge under the rated voltage of the generator.

This rectified voltage provides the actual pulse signal and the supply voltage the control amplifier.

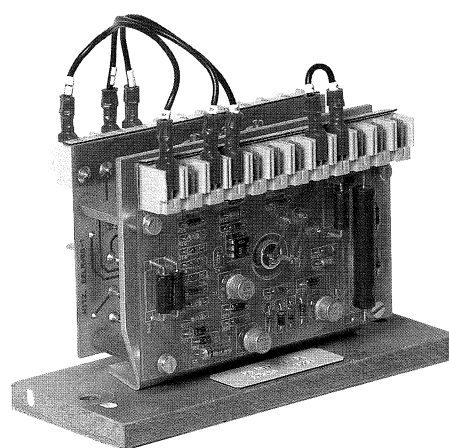
The regulator module supplies output terminal 15 with a control voltage of approx. 1 to 10 V, which is proportional to the control deviation.

Depending on the reference potential of terminal 16, terminal 12 of the comparator point of the control amplifier can be given an additional D.C. pulse, e.g. for reactive power control in parallel operation.

For tuning to the signal level, a rheostat must be soldered onto the available soldering pins.

The power supply for the gate control module(s) is available from terminal 11.

Fig. 13 Voltage regulator, SPRESY 15



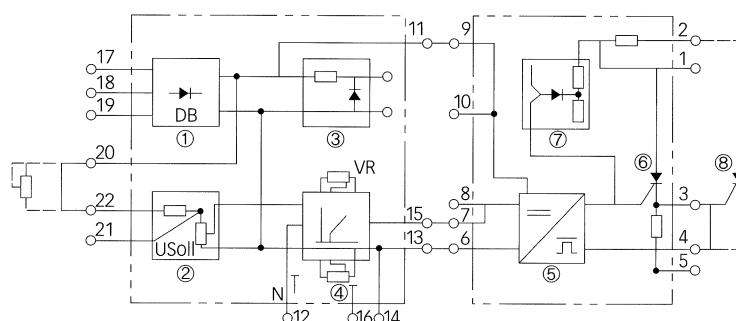
In the control circuit of the firing module, a time adjustable firing impulse for the thyristor is formed from the control voltage of terminal 15 in comparison with a saw tooth voltage.

The overvoltage protector operates at voltages over 600 V between terminals 1 and 5, then switches the thyristor through.

The excitation current is normally bucked with a single pulse.

If higher excitation is required, two firing modules for two-pulse "buck" operation will be provided.

Fig. 14 Block diagram of voltage regulator, SPRESY 15



- ① Six-pulse rectifier bridge
- ② Reference/actual value comparator
- ③ Power supply
- ④ Control amplifier
- ⑤ Firing pulse control
- ⑥ Thyristor in buck circuit
- ⑦ Overvoltage protector
- ⑧ Auxiliary power thyristor

Fig. 15 Connection diagram of generator (for generator top mounted AVR)

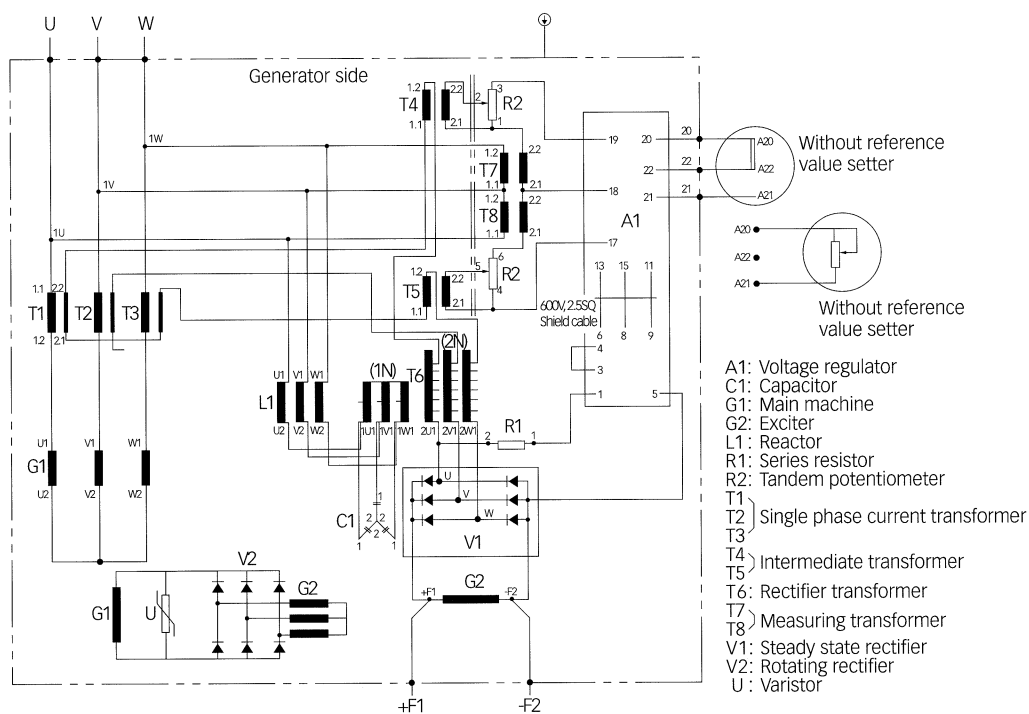
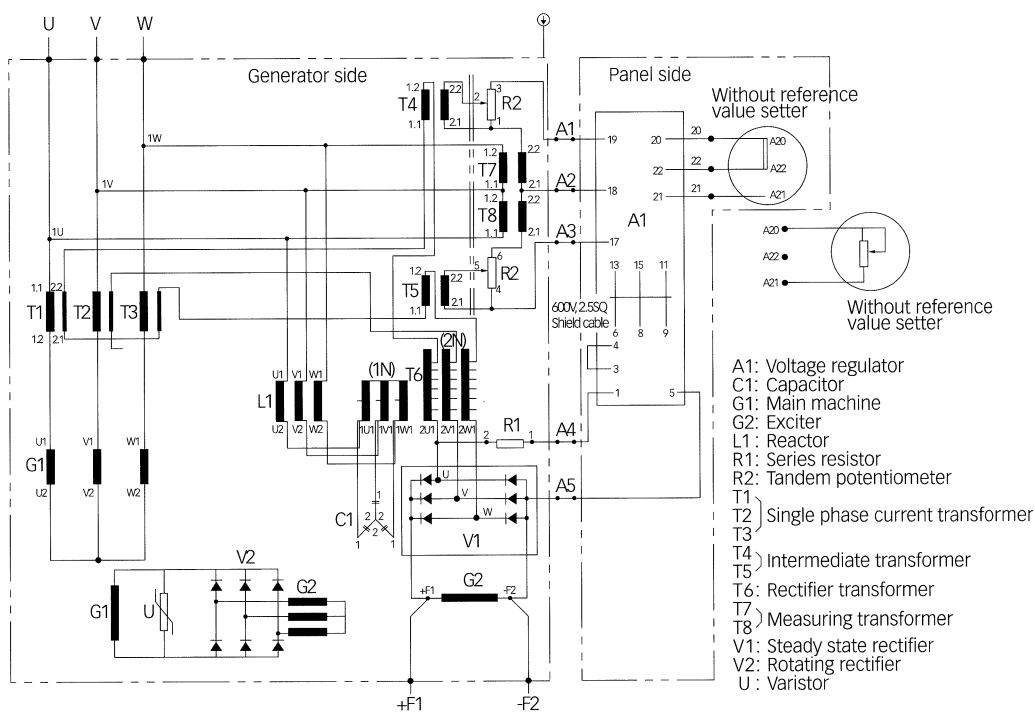


Fig. 15-1 Connection diagram of generator (for panel mounted AVR)



2) Installation

The excitation equipment, thyristor voltage regulator, main machine and exciter are all factory-wired. If necessary, the mains leads and the reference-value selector should be connected to the terminals in the terminal box according to the connection diagram supplied with the machine.

2.2 Operation (SPRESY 15)

1) Thyristor voltage regulator

When the generator is operating by itself, the thyristor voltage regulator controls the generator voltage to the preset reference value.

Frequency changes due to the droop characteristics of the prime mover do not influence the accuracy of the generator output voltage.

Design and adjustment of the main machine, exciter, excitation equipment, thyristor voltage regulator and reference-value selector permit gradual changes in the generator output voltage from 95% to 105% rated voltage via potentiometer U_{soll} under steady-state conditions and at loads varying between no load to rated load and power factors between 0.8 and unity, unless otherwise specified on the rating plate.

If the generators are operated at less than 95% or more than 105% rated voltage, their output must be reduced. Unrestricted operation with no load (opened generator breaker) and partial speeds is permissible.

During operation, the excitation circuit must not be interrupted since this would give rise to voltage surges. If the generator must be de-excited, this can be accomplished by short-circuiting secondary side of rectifier transformer (T6) (Fig. 14).

2) Transformer adjustment

The tapings used on the transformers are recorded at test report. It is strongly recommended that the original adjustments be left unchanged.

No responsibility can be assumed by the supplier for any damage or incorrect operation resulting from a change in the original adjustments.

In the case of identical plants, the THYRIPART excitation system or single parts may be interchanged if necessary; those transformer tapings must always be used in accordance with the original ones.

3) Direction of rotation of the generator

The generators are generally suitable for clockwise and anti-clock-wise operation. Generators must run only in the corresponding direction of rotation as on the data plate of rotating (arrow mark).

To change the direction of rotation it is necessary to change the connections according to the connection diagram e.g. phase rotation check and to check whether only one definite direction of rotation is permissible for mechanical reasons (e.g. fan with curved fan blades).

4) Regulator gain setpoint of voltage integral action

The regulator module includes the three potentiometers U_{soll} , V_r and T_n .

The generator rated voltage is adjusted in the factory on potentiometer U_{soll} and the transient response characteristic of the regulator on potentiometers V_r and T_n .

The regulator gain is adjusted on the potentiometer V_r , but the integral action time and the optimum transient response characteristic are adjusted on the potentiometer T_n .

Turning the knob of V_r in the direction of descending numerals and that of T_n in the direction of ascending numerals normally stabilizes the control circuit and reduces the control rate.

The setpoint of the generator voltage can be shifted via potentiometer U_{soll} and via a supplementary external reference-value selector ($R = 1.5 \text{ k}\Omega$, $P > 1 \text{ W}$) to be connected to auxiliary terminals 20 and 21 (Fig. 14) with the above potentiometer set to mid-position.

The new adjustment of the potentiometer must be fixed with the aid of the set screw.

5) Parallel operation, droop compensating equipment

When provided with droop compensation, a brushless synchronous generator is suitable for operating in parallel with other generators or with a supply system.

The kW output is adjusted through the governor of the prime mover.

The speed characteristic of the prime mover should be linear and rise by a min. of 3% and a max. of 5% between rated load and no load.

The droop compensating equipment ensures uniform distribution of the reactive power and reduces the generator output voltage in linear with the increase in reactive current.

The droop compensating circuit is adjusted to provide a generator voltage droop of 4% at zero p.f. and no voltage droop at unity p.f. between no load and rated load as a function of the generator current.

With this setting, a voltage droop of 2.4% is obtained at 0.8 p.f.

When operated by it self or in parallel with generators having the same voltage characteristic, a voltage regulation of $\pm 2.5\%$ is thus obtained.

With the generator operating by itself, no droop compensating equipment is required.

It can be deactivated by short-circuiting the secondary side of the intermediate transformers.

If the neutrals of alternators in a system are interconnected and/or connected directly to those of transformers and loads, balancing currents of three times system frequency can occur.

Their magnitude must be measured in the alternator neutral conductors under all possible load conditions to be met in service.

To prevent the alternators from overheating, these currents of three times system frequency must not exceed approximately 50% of the respective alternator current.

Excessive currents should be limited, e.g. by means of neutral reactors or similar fitted on the plant side.

A specific enquiry is necessary for these items.

2.3 Maintenance (SPRESY 15)



Hazardous voltage

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

No periodic maintenance inspections of the THYRIPART excitation equipment are required.

Excessive dust deposits should, however, be removed using dry, compressed air.

In the case of faults it is advisable to check voltage regulator, excitation equipment, and main machine with exciter separately.

For troubleshooting in the thyristor voltage regulator, all the leads connecting excitation equipment and thyristor voltage regulator must be disconnected.

In this case the generator voltage must rise above the maximum reference value as given under "Description" below.

In this case the thyristor voltage regulator is defective. Trouble shooting should be continued according to table 4-2 on page 50.

2.4 Mode of Operation (6 GA 2491)

1) Description

Brushless synchronous generators consist of the main machine and the exciter.

The main machine field winding is powered from the exciter rotor winding via a rotating, three-phase bridge-connected rectifier set.

The exciter is powered from THYRIPART excitation equipment.

The excitation equipment and the thyristor voltage regulator are combined in the THYRIPART excitation system.

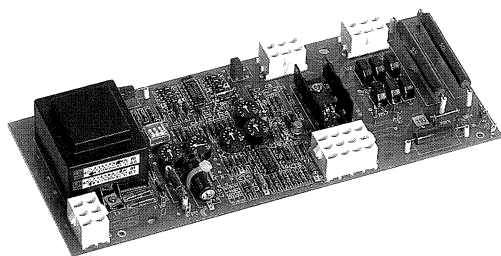
The field current required is supplied to the main machine via the excitation unit.

This is adjusted in such a manner that the generator voltage which is above the maximum setpoint value develops over the entire load range when the voltage regulator is inactive (opening the plug connection X).

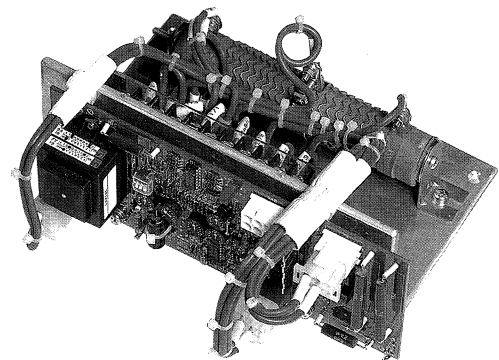
The thyristor voltage regulator provides a bypass for a variable portion of the current supplied by the excitation unit for controlling the generator voltage.

The voltage regulator 6 GA 2492 is comprised of the voltage regulator 6 GA 2491 and the power module (rectifier, thyristor in "buck" circuit, and resistor in "buck" circuit).

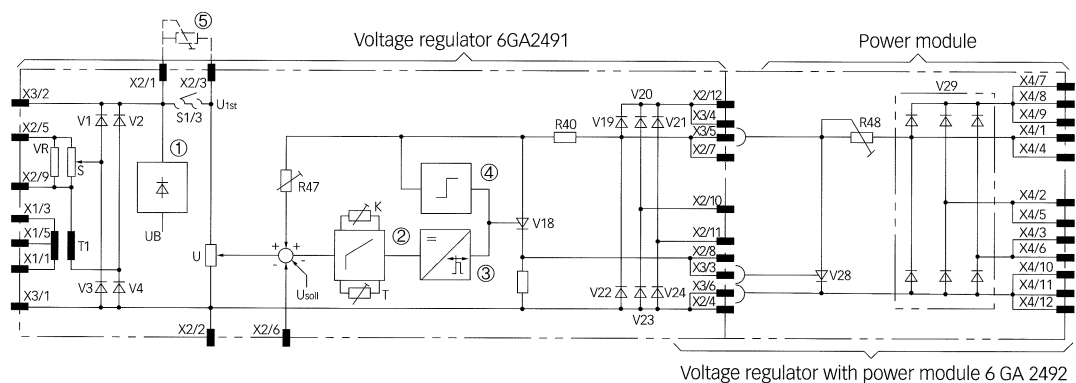
⇒ Fig. 16 Voltage regulator "6 GA 2491"
(for generator top mounting)



⇒ Fig. 17 Voltage regulator "6 GA 2491"
(for panel mounting)

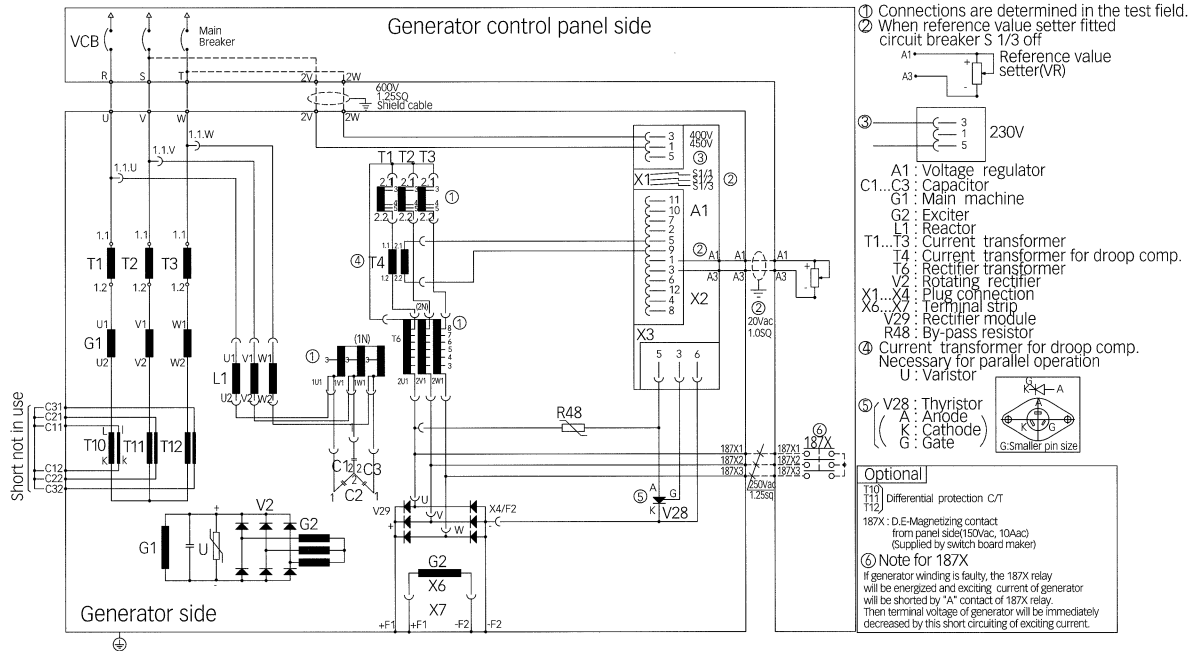


⇒ Fig. 18 Block diagram of voltage regulator "6 GA 2491"

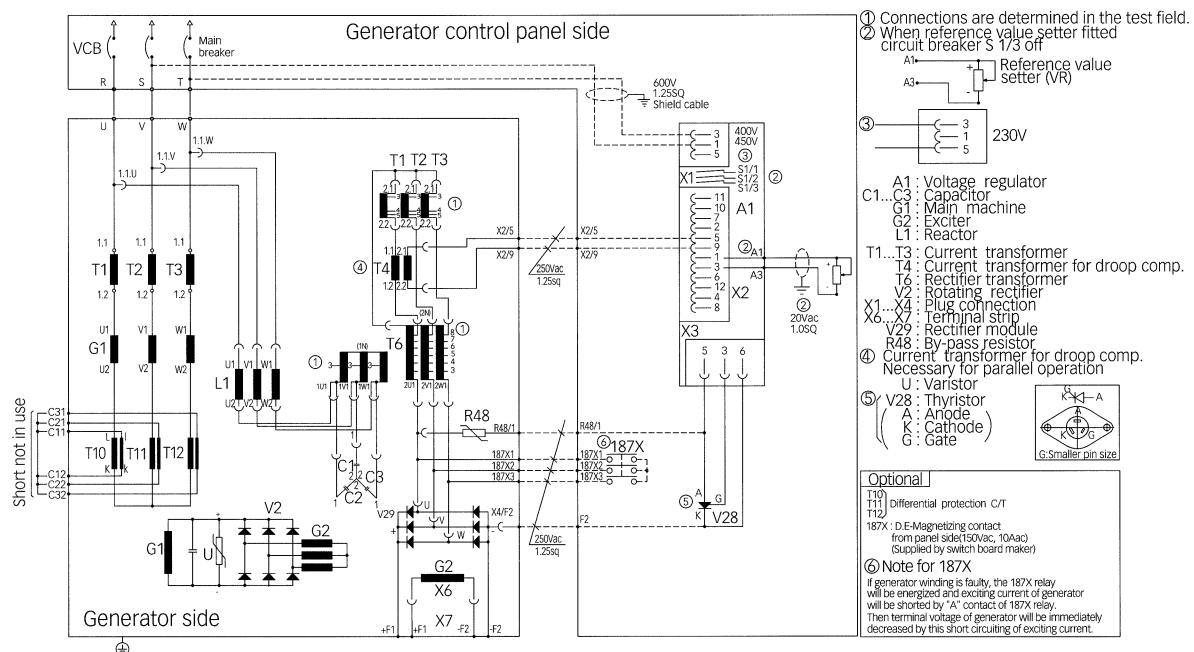


- | | | | | | | | |
|-----|-------------------------------|-----|--|---|---------------------------------|---|-----------------------|
| V29 | Excitation rectifiers | S | Drop potentiometer | ① | Power supply | ② | Control amplifier |
| U | Reference value potentiometer | K | Potentiometer, controller gain | ③ | Pulse unit | ④ | Overvoltage protector |
| T | Potentiometer, reset time | R47 | Potentiometer, disturbance feedforward | ⑤ | External reference value setter | | |
| V28 | Thyristor in "buck" circuit | R48 | Resistor in "buck" circuit | | | | |

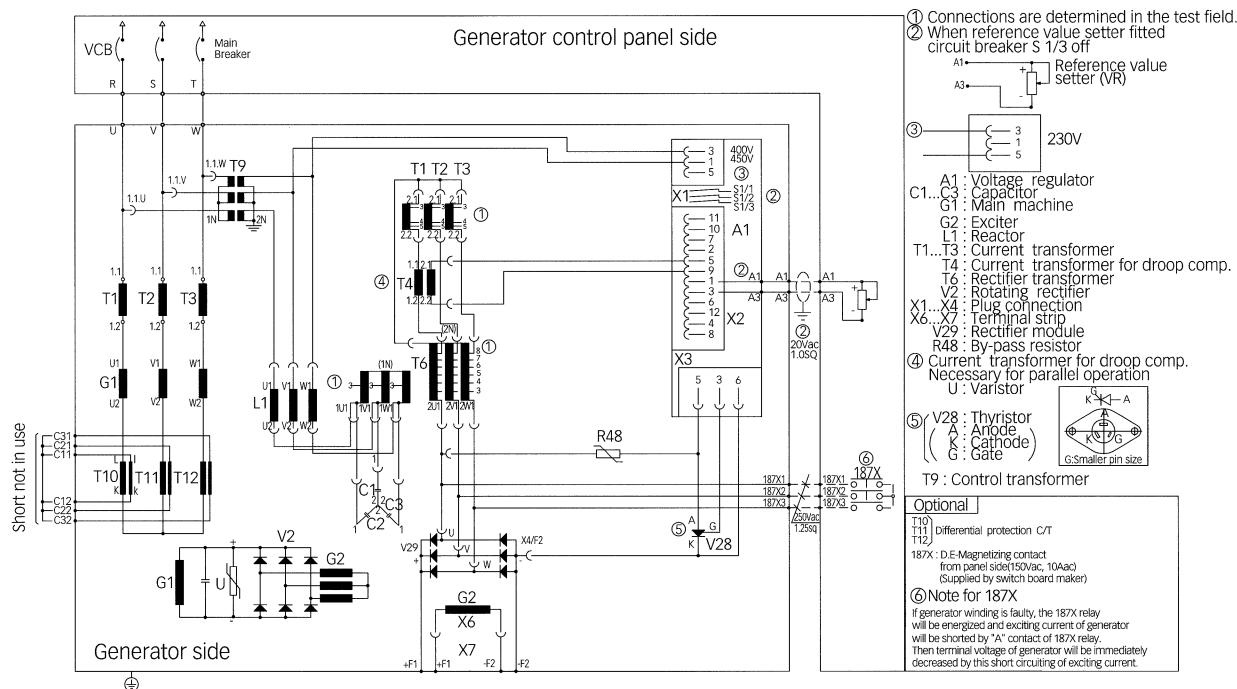
⇒ Fig. 20 Connection diagram of generator (for generator top mounted AVR: 450 Fr~



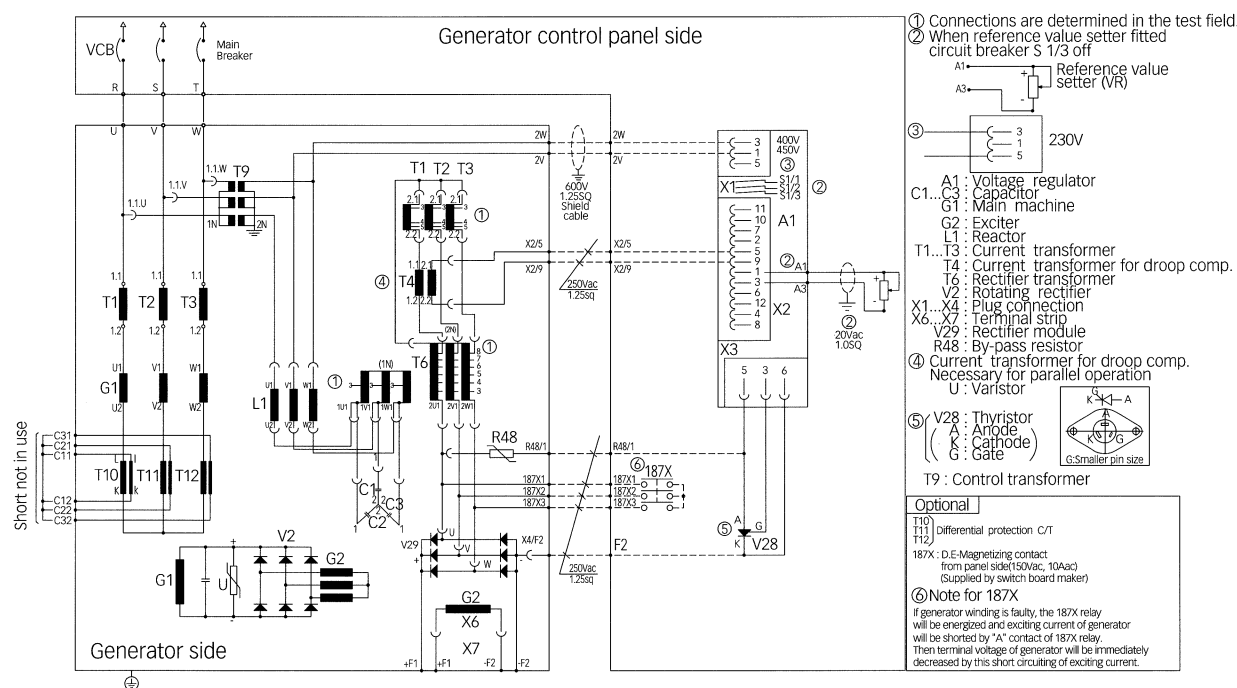
⇒ Fig. 20-1 Connection diagram of generator (for panel mounted AVR: 450 Fr~



⇒ Fig. 21 Connection diagram of medium & high voltage generator (for generator top mounted AVR): HS. 7



⇒ Fig. 21-1 Connection diagram of medium & high voltage generator (for panel mounted AVR): HS. 7



2) Mode of operation of regulator

The generator voltage is fed to the regulator via plug connector X1 in a single-phase, two-circuit arrangement. Transformer T1 steps down the generator voltage which is then rectified by the load-side rectifier bridge V1, V4. This rectified voltage provides the actual pulse signal "U_{ist}" the setpoint voltage U_{oll} and the supply voltage ① for the regulator.

If the system uses a reactive current compensator, current transformer T15 or interposing transformer T4 of the excitation unit is connected to load resistor R1 via plug-in contacts X2/5 and X2/9.

In this operating mode the actual voltage is composed of the secondary voltage of transformer T1 and the voltage of load resistor R1.

The magnitude of the resulting reduction in generator voltage can be set with potentiometer S.

If an external set point selector is used, this is connected by contacts X2/1 (A1) and X2/3 (A3).

In this case microswitch S1/3 of the regulator must be opened.

A DC voltage of 0 to 10 V can be fed in via plug-in contacts X2/6 and X2/2.

This voltage acts on the comparator point of the control amplifier.

The setpoint can thus, for instance, be preset by higher-level equipment.

Control amplifier ② (proportional again adjustable by potentiometer K and reset time by potentiometer T) outputs a DC voltage which is converted into a time-adjustable firing pulse for thyristor V18 or V28 via the loadside pulse unit ③.

The generator excitation circuit is fed from rectifier bridge V29.

Resistor R48 and thyristor V28 form a parallel bypass circuit to the field winding through which part of the current supplied by the excitation unit flows.

This method provides for generator voltage control.

In order to optimize the correcting action, a disturbance variable is injected into the control amplifier via resistor R47.

Overvoltages above DC 600 V in the excitation circuit cause the overvoltage protector ④ to operate and continuously fire the thyristor.

Protection is thus provided for the stationary excitation circuit of the generator.

3) Installation

The excitation equipment, thyristor voltage regulator, main machine, and exciter are factory-wired.

If necessary, the main leads and the reference-value selector must be connected to the terminals in the terminal box according to the connecting diagram supplied with the machine.

2.5 Operation (6 GA 2491)

1) Thyristor voltage regulator

The voltage regulates the voltage so that it complies with the setpoint selected.

Frequency changes due to the droop characteristics of the prime mover do not affect the voltage accuracy.

The design and adjustment of the generator and the excitation equipment permit continuous changes of the terminal voltage in the range of $\pm 5\%$ rated voltage via the setpoint selector under steady-state conditions and at loads varying from no load to rated load, and power factors from 0.8 to unity unless specified otherwise on the rating plate.

If several rated voltages and frequencies are indicated on the rating plate, the above data apply to each of the rated voltages stated.

If the generators are operated at voltages exceeding $\pm 5\%$, the generator output must be reduced.

Unrestricted operation at no load is permitted if the speed is reduced.

During operation, the excitation circuit must not be interrupted since this would give rise to voltage surges. If the generator must be de-excited, this can be accomplished by short-circuiting the secondary side of rectifier transformer (T6) (Fig. 14).

2) Transformer adjustment

The tapings used on the transformers are shown in the test report.

It is strongly advised not to change the original adjustments.

No responsibility can be assumed by the supplier for any damage or incorrect operation resulting from a change in the original adjustments.

In the case of identical plants, the THYRIPART excitation system or the individual components can be interchanged if necessary.

The transformer tapings, however, must be used in accordance with the original ones.

3) Regulator gain, setpoint voltage integral action

The control module comprises potentiometers U, K, T, R 47 and S.

The rated generator voltage has been adjusted in the factory on potentiometer U, and the dynamic behaviour of the regulator on potentiometers K, T and R 47.

The settings are shown in the test report.

Potentiometer K is used to adjust the controller gain and potentiometer T is used to adjust the integral action time, whereas potentiometer R 47 is used to inject a disturbance variable into the comparator point of the control amplifier in order to adjust dynamic behaviour.

Turning the knob of K and R 47 in the direction of descending numerals and that of T in the direction of ascending numerals normally stabilizes the control circuit and reduces the control rate.

The stability of the control circuit can also be improved by increasing the bucking resistance, but the voltage setting range of the regulator then is reduced at the lower band.

The setpoint of the generator voltage can be shifted via potentiometer U or an additional external setpoint selector (R = 4.7 kΩ, P greater than 1 W) can be connected to terminals A1 and A3.

Potentiometer U should be set to the centre position, and microswitch S 1/3 on the printed-circuit board should be opened.

4) Parallel operation by droop compensation equipment

When provided with droop compensation equipment, brushless synchronous generators are suitable for operating in parallel with each other or with a supply system.

The KW output is adjusted by the governor of the prime mover.

The speed characteristic of the prime mover should be linear and rise by at least 3% and not more than 5% between rated load and no load.

Droop compensating equipment ensures uniform distribution of the reactive power and reduces the generator output voltage in linear with the increase in reactive current.

Regarding generators with current transformer for droop compensation, potentiometer S in the regulator is adjusted so that there is no reduction in the generator voltage at unity p.f. but a 4% reduction at zero p.f.

The corresponding voltage reduction at 0.8 p.f. is 2.4%. In isolated operation and at any loading condition of the generator, the droop compensation provided for the generator voltage can be checked with the following relationship:

$$\Delta U_{st} = 4\% \sqrt{1 - \cos^2 \phi} \cdot I_B / I_N (\%)$$

$$\text{e. g. at } 0.8 \text{ pf, } I_B / I_N = 1,$$

$$\Delta U_{st} = 4\% \sqrt{1 - 0.8^2} \cdot 1 = 2.4 (\%)$$

If the generator is to operate by itself, droop compensation equipment is not required. It can be deactivated by short-circuiting the secondary side of the associated current transformer or setting potentiometer S on the regulator to the left-hand stop.

5) Parallel operation by cross-current compensation

When provided with cross-current compensation, brushless synchronous generators are suitable for the operation in parallel with other generators of the same capacity.

This parallel operation by cross-current compensation has the same voltage under all loads condition from no-load to rated load.

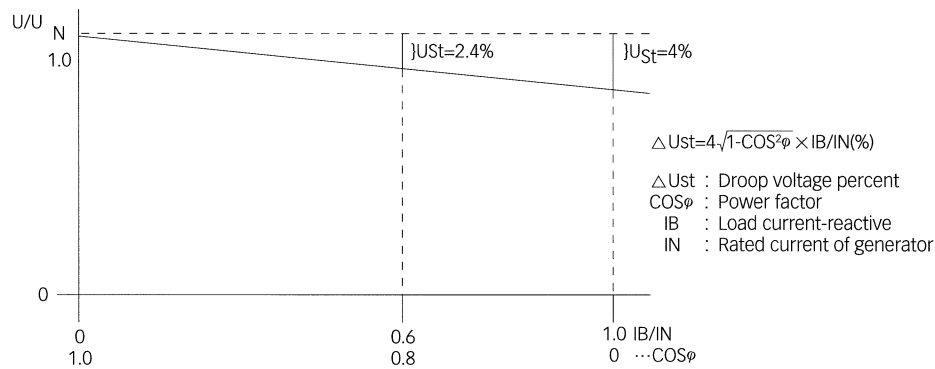
If the neutral points of several generators are interconnected or connected direct with the neutral points of transformers and loads, currents at 300% frequency may occur.

Their magnitude should be checked by measurements in the neutral conductors of the generators under all load conditions occurring.

To avoid overheating the generators, these currents must not exceed a value equal to about 50% of the rated generator current.

Higher currents should be limited by installing neutral reactors or similar means.

⇒ Fig. 22 Droop characteristic curve



2.6 Maintenance (6 GA 2491)

⚠ DANGER

Hazardous voltage

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

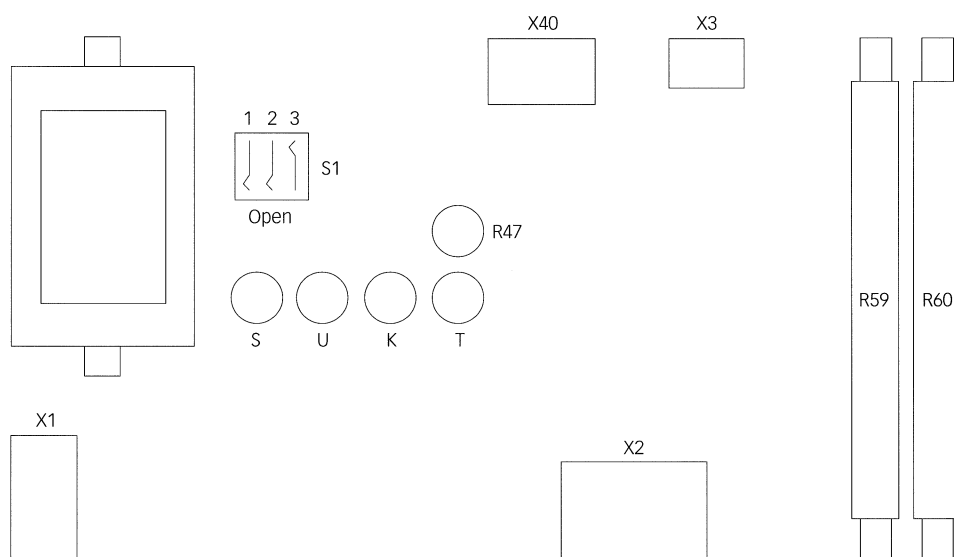
No periodic maintenance inspections of the THYRIPART excitation equipment are required.

Excessive dust deposits should, however, be removed using dry, compressed air.

For the maintenance of generator of its related parts, refer to trouble-shooting table 4-3, as shown on page 51.

When ordering spare parts, please state the type and serial number of the generator as specified on the rating plate.

⇒ Fig. 23 Position of potentiometers on the voltage regulator



3.1 Installation & Inspection Check List

**DANGER****Hazardous voltage**

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

**NOTICE**

Before the initial starting for in-service, check the items on table 3-1 for sure.

If not, may cause fatal damage in generator.

The purpose of this checklist is to ensure that all installation and inspection work is fully carried out.

It is therefore essential for the list to be filled in carefully. The number of relevant questions will depend on the scope of the work to be carried out,

In the "Answer" column, "yes" or "no" or "n/a" (for "not applicable") should therefore be checked off in each case. In some lines, additional data or information must be entered or irrelevant items deleted.

If any further explanations are necessary, they should be placed in the report or final spec of the generator.

→ Table 3-1. Installation & inspection check list

Condition of machines before installation	Answer			Installation	Three-phase A.C. machines Standard checks	Answer			Installation
	Yes	NO	n/a			Yes	NO	n/a	
Packing of all machine components undamaged?					Insulation resistance values at °C winding temperature				
Paintwork undamaged?					3 phases/earthed frame: MΩ				
Stator					phase/phase: MΩ				
General					Measuring voltage: V				
Winding guards properly fixed and locked?					(usually 500 V, DC)				
All parts of the enclosure properly assembled?					Rotor				
Stator foot bolts tightened properly?					Insulation resistance values at °C winding temperature				
Stator dowel-pinned?					Rotor winding/earthed shaft: MΩ				
Earthing or protective conductor connected?					Measuring voltage: V				
HV machines must be connected to the earth bus by a conductor of equal cross-section.					(always 500 V, DC)				
LV machines are to be included in the protection arrangements by the connection of the green-yellow protective conductor or the concentric conductor of the cable to the protective conductor connecting terminal.					Electrical connections				
					Cables/bars properly connected?				
					Cable strain-relief connected?				

→ Table 3-2. Installation & inspection check list

Bearings	Answer			Installation	Oil flow rates reference	Answer			Installation
	Yes	NO	n/a			Yes	NO	n/a	
Journal bearings (Lubricating oil used)					Drive-end journal bearing ℓ /min				
Oil grade					Non-drive-end journal bearing ℓ /min				
Viscosity at °C					The specified oil flow rates are indicated on the bearing instruc- tion plate. With the specified flow rates, about half the clear cross-sections of the oil drain pipes are filled with oil.				
Condition of bearings and shaft					Rolling bearings				
Have any shipping bearing shells and/or shaft blocks been removed?					Grease lubrication				
Anti-rust coating removed? shaft journals satisfactory?					Type of grease				
Oil rings fitted in the bearings?					General				
Circularity of oil rings satisfactory?					Check the flow of cooling water (IP44):				
Oil-ring slots of bearings shells deburred and rounded off?					Check the safety device in service, or not?				
Joint locked?									
Bearing sealing rings properly fitted?									
Bearing thermometers fitted?									
All bearing bolts properly tightened and locked?									
Bearing filled with oil to centre marks of oil-level sight glasses?									
Running of oil rings checked?									
Oil circulation system									
Oil pipework cleaned and pickled?									
Pressure reducer fitted?									

1) Inspection schedule

Daily

Check bearing.
L.O. condition.
Oil ring.
Noise.
Vibration.
Temperature.
Check electric circuit.
Earth fault by earth lamp.
Check loading condition.
Voltage, output kW, current.

Monthly

Check insulation resistance.
Caution: Before checking insulation resistance,
disconnect and earthed the leads from A.V.R.
Bolts and nuts.

Tighten all bolts and nuts.
Check ventilation openings.
Check air intake opening and its air filter, clean or
replace the filter if necessary.

Every 6 Monthly

Change lubrication oil and clean bearing.
At the same time, check fitting or seating of bearing.
Clean generator.

CAUTION

Flying dirt, dust or other particles.
May cause eye injury.
Wear safety glasses and dust mask when using compressed air.

Inspect generator winding and air filters for dirt, dust, oil, and salt vapor accumulation.
Blow off contamination by dry and oil free compressed air.
Wipe off accumulated vapor with lint-free cloth and adequate solvent.
Check electrical connection.

DANGER

Hazardous voltage
Will cause death, serious injury, electrocution or property damage.
Disconnect all power before working on this equipment.

Inspect for loose electrical connection.
Inspect cracked, frayed or oil soaked insulation.
Tighten or replace if necessary.

3.2 Flange-Type Sleeve Bearing (for ring lubrication system)

1) Mounting

The flange-type sleeve bearings of electrical machines are of the split type.
They are ring-lubricated (Fig. 25) and are subject to the following instructions supplementing and modifying the operating instructions of the machine:

Corresponding to the operating conditions the sleeve bearings of new machines have a favorable bearing clearance which should not be changed.
Scraping (spot-grinding) is not allowed not to make worse the antifrictional qualities.

It is recommended that the contour of the transmission element remains within the hatched range (see Fig. 25) to remove the upper part of the bearing housing for maintenance without removing the transmission element.

Before the machines are aligned and commissioned, the bearings should be filled with lubricating oil since the machines are delivered without oil in the bearings (oil type is indicated on the name plate of the bearing).

2) Operating description

NOTICE

Before starting, check if the bearing is filled with oil or not to the necessary oil level.

Upon stopping, the shaft rests on the lower bearing; there is metal-to-metal contact.

During the start-up phase, the shaft rubs against the anti-friction metal of the bearing. Oil lubrication is used.

After having reached its transition speed, the shaft creates its oil film.

At this point, there is no further contact between the shaft and bearing.

CAUTION

Prolonged operation at extremely slow rotation speeds (several rpm) without lubrication could seriously damage for the service life of the bearing.

CAUTION

If the bearing temperature exceeds the normal operating value by 15 K, stop the machine immediately.
Inspect the bearing and determine the causes.
Setting values of a safety device
-Alarm: 90°C
-Trip: 95°C

3) Oil change

Check the bearing temperature regularly.
The governing factor is not the temperature rise itself, but the temperature variations over a period of time.
If abrupt variations without apparent cause are noticed, shut down the machine and renew the oil.

The lubrication oil indicated on the data plate is used for starting up the machines at an ambient temperature of above +5°C.

At lower temperatures (to about -20°C), it is necessary to preheat the oil.
If the ambient temperature is below -20°C another type of oil according to the special conditions is used.
Do not mix oils of different grades.

Recommended oil changing intervals are about 3000 and 6000 operating hours in the case of intermittent and continuous duty.

When cleaning, first flush the bearings with kerosene and then with oil.

NOTE

If the lubrication oil contains unusual residues or its color looks changed, bearings shall be inspected.

Pour in the kerosene and oil through the top sight-glass hole.

Leave the drain open until all the kerosene has been removed and clean oil runs out.

Now, plug the drain and fill the bearing with oil up to the centre of the lateral inspection glass.

When the machine has run up to speed, check the oil ring through the top inspection glass to see that it rotates correctly, and check the bearing temperature.

Should the bearing temperature not drop to the normal value after the oil change, it is recommended that the surfaces of the bearing shells be inspected.

If the bearings are fitted with thermometers for checking the bearing temperature, fill the thermometer well in the upper bearing shell for thermofeeler with oil to improve heat transfer and top up with oil every time the lubricating oil is changed.

4) Dismantling, assembling

CAUTION

When insulated shaft current is applied, the accessories in contact with the bearing housing must be electrically insulated.

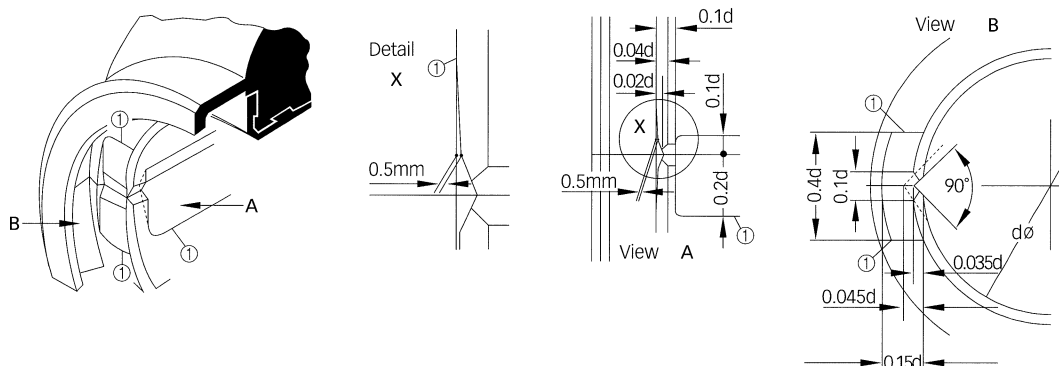
When dismantling the machine, the lower part of the bearing housing need not be unscrewed from the end shield. When opening the bearing housing, locate which side of the machine the adjusting shims (upper and lower parts) are installed.

These shims must be installed in the same place when assembling the machine.

Exceptions are possible if the stator core was changed. Drain the oil, take off the upper part of the bearing housing and the upper bearing shell, lift the shaft very slightly and turn out the lower bearing shell and the sealing rings in a peripheral direction.

The oil ring can be withdrawn by holding it at an inclined position to the shaft.

⇒ Fig. 24 Oil pockets and oil grooves



① flattened to running face

If only slight damage has occurred to the bearing surface, it may be re-conditioned by scraping, as long as the cylindrical shape of the bore is maintained, so that a good oil film can form.

The lining must be renewed if more serious damage is found.

The oil pockets and grooves of the new lining or scraped shell should be cleaned and finished with particular care (Fig. 24).

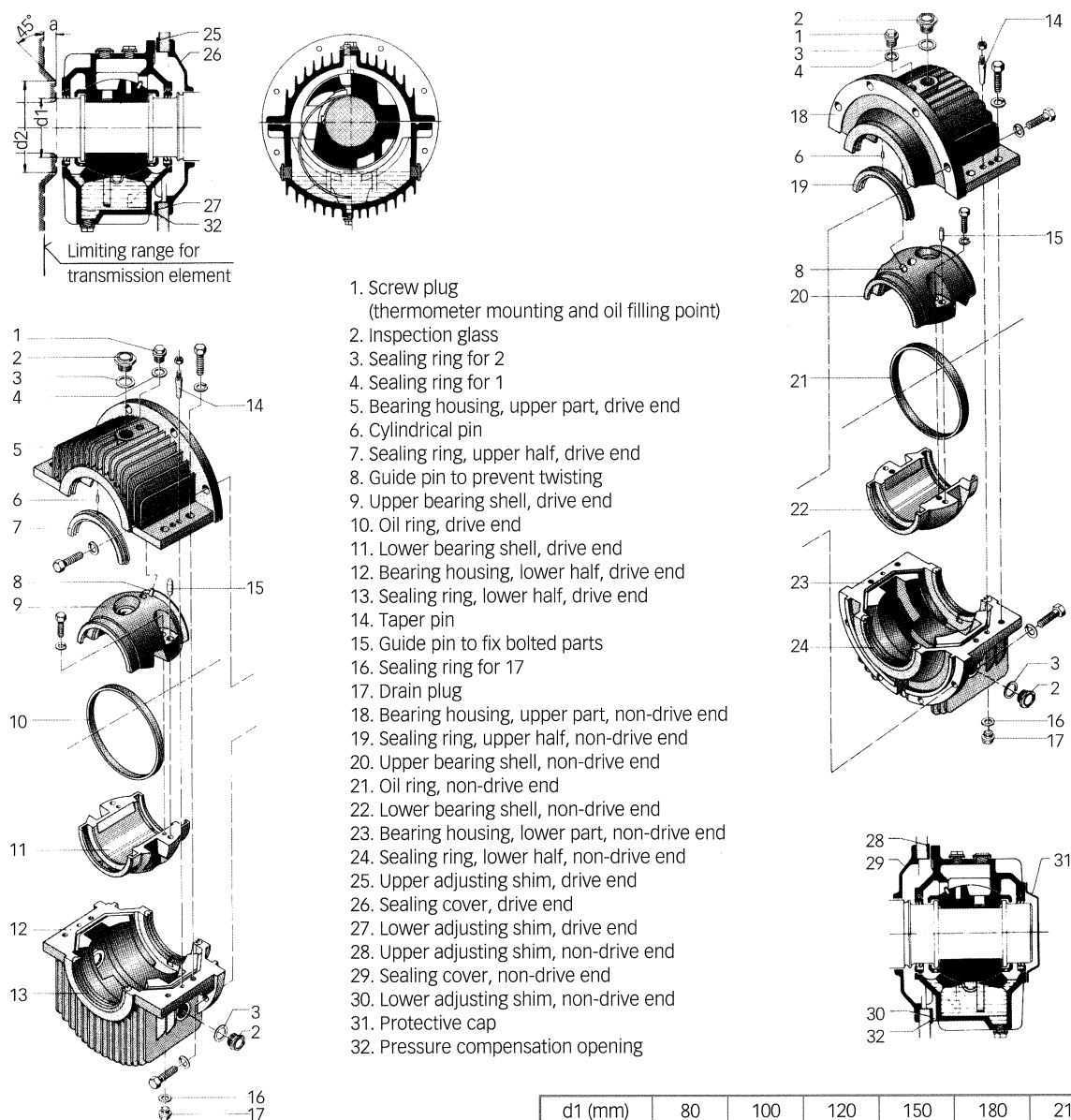
The replacement bearing shells are delivered by the works with a finished inner diameter.

Oil rings which have become bent through careless handling will not turn evenly.

Straighten or replace such rings.

Replace any damaged sealing rings.

→ Fig. 25 Ring-lubricated flange-type sleeve bearings (examples, delivered design may deviate in details)



d1 (mm)	80	100	120	150	180	215
d2 (mm)	140	160	170	190	210	245
a (mm)	8	8	10	15	18	22

3.3 Flange-Type Sleeve Bearing (forced lubrication system)

1) Mounting

The flange bearings of these electrical machines are of the split type.

They are lubricated by an oil ring and provided additionally for forced lubrication (Fig. 27)

They are subject to the following instructions supplementing and modifying the operation instructions of the machine:

Corresponding to the operating conditions, the sleeve bearings of new machines have a favorable bearing clearance which should not be changed.

Scraping (spot-grinding) is not allowed not to make worse the antifrictional qualities.

It is recommended that the contour of the transmission element remains within the hatched range (see Fig. 27) to remove the upper part of the bearing housing for maintenance without removing the transmission element.

Before the machines are aligned, the bearings should be filled with lubricating oil (oil type is indicated on the name plate of the bearing) since the machines are delivered without oil in the bearings.

Connect the bearings to the oil pump, oil tank and cooler before commissioning the machines.

No reducers must be fitted in the piping.

Install a regulating orifice on the oil supply line to protect the bearing from flooding.

If the oil pump fails, the lubrication maintained by the oil ring is effective for about 15 to 30 minutes, provided the oil contained in the bearing does not drain away.

To prevent this, connect the oil discharge tube on that side where the oil ring moves downward into the oil. In addition to this, install a non-return valve in the oil supply line.

As an alternative raise the level of the oil in the bearing to 100 mm.

Oil discharge tubes must terminate flush with the inside surface of the bearing housing to prevent the oil rings from rubbing against the tubes.

Fill the oil tank with the lubricating oil indicated on the data plate.

This oil is used for starting up the machine at an ambient temperature of above +5°C.

At lower temperatures, preheat the oil.

It is recommended to use a control system adjusted in such a manner to have an oil temperature of 15 to 20°C in the tank and to have a preheated oil flow through the cold bearings for 5 to 10 minutes before starting up the machine.

Do not mix oils of different grades.

The necessary pressure of the oil entering the bearings and the oil flow rate are indicated on the data plate.

Adjust these values when starting up the machine for the first time and correct them when the bearing has attained its normal running temperature.

The oil in the bearing housing must not ascend over the center of the lateral inspection glass.

If the bearings are fitted with thermometers for checking the bearing temperature, fill the thermometer well in the upper bearing shell for the thermofeeler with oil to improve heat transfer and top up with oil every time the lubricating oil is changed.

In the case of insulated bearings, make sure that the insulation is not bridged by the tubes.

Interrupt the electrical conductivity of the tubes near the bearings, e.g. by installing oil-resistant fittings of plastic material or hoses of rubber or plastic material.

2) Operating description

NOTE

Before starting, check if the bearing is filled with oil or not to the sufficient oil level.

Upon stopping, the shaft rests on the lower bearing; there is metal-to-metal contact.

During the start-up phase, the shaft rubs against the anti-friction metal of the bearing.

Oil lubrication is used.

After having reached its transition speed, the shaft creates its oil film.

At this point, there is no further contact between the shaft and bearing.

CAUTION

Prolonged operation at extremely slow rotation speeds (several rpm) without lubrication could seriously damage for the service life of the bearing.

⚠ CAUTION

If the bearing temperature exceeds the normal operating value by 15 K, stop the machine immediately. Inspect the bearing and determine the causes. Setting values of a safety device

- Alarm: 90°C
- Trip: 95°C

Switch on the oil pump before starting up the machine. The use of a pump driven from the shaft of the main machine is permitted only in special cases, such as when the acceleration and coasting times are short.

3) Oil change

Check the bearing temperature regularly. The governing factor is not the temperature rise itself, but the temperature variations over a period of time. If abrupt variations without apparent cause are noticed, shut down the machine and renew the oil.

Recommended oil changing intervals are about 20,000 operating hours.

After the machine has come to a stand-still and the old oil is drained out of the bearings and oil tank operate the oil pump with kerosene for a short time and then with oil to clean the bearings.

For the oil pump, the oil tank, the cooler and the pipe lines: Pour in the kerosene and then the oil through the filling opening of the oil tank.

Leave the drains open from time to time until all the kerosene has been removed and clean oil runs out of the bearings and oil tank.

Then plug the drains and fill the tank with oil.

Should the bearing temperature not drop to the normal value after the oil change, it is recommended that the surfaces of the bearing shells be inspected.

4) Dismantling, assembling**⚠ CAUTION**

When insulated shaft current is applied the accessories in contact with the bearing housing must be electrically insulated.

When dismantling the machine, the lower part of the bearing housing need not be unscrewed from the end shield.

When opening the bearing housing, locate on which side of the machine the adjusting shims (upper and lower parts) are installed.

These shims must be installed in the same place when assembling the machine.

Exceptions are possible, if the stator core was changed. Drain the oil, take off the upper part of the bearing housing and the upper bearing shell, lift the shaft very slightly and turn out the lower bearing shell and the sealing rings in a peripheral direction.

The oil ring can be withdrawn by holding it at an inclined position to the shaft.

If only slight damage has occurred to the bearing surface, it may be reconditioned by scraping as long as the cylindrical shape of the bore is maintained, so that a good oil film can form.

The lining must be renewed if more serious damage is found.

The oil pockets and grooves of the new lining or scraped shell should be cleaned and finished with particular care (Fig. 26).

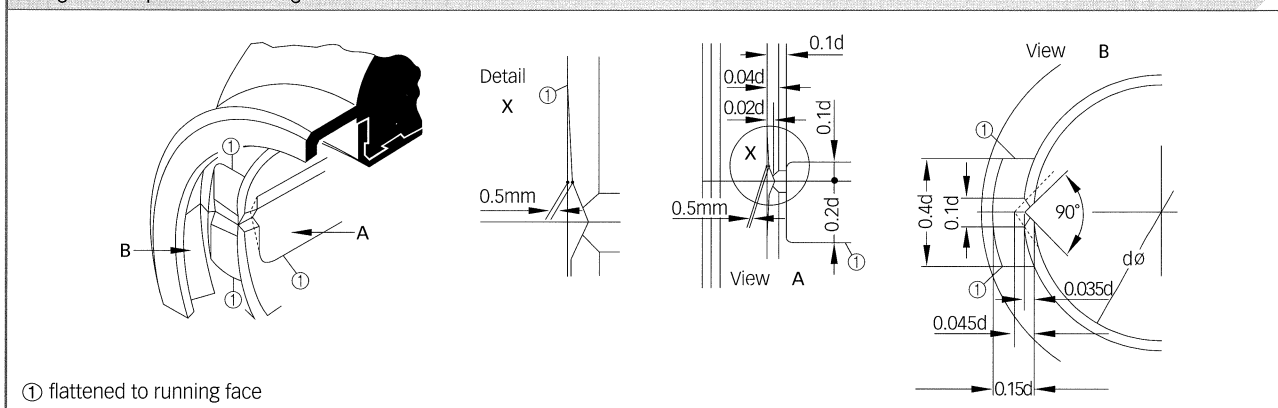
The replacement bearing shells are delivered by the works with a finished inner diameter.

Oil rings which have become bent through careless handling will not turn evenly.

Straighten or replace such rings.

Replace any damaged sealing rings.

➔ Fig. 26 Oil pockets and oil grooves



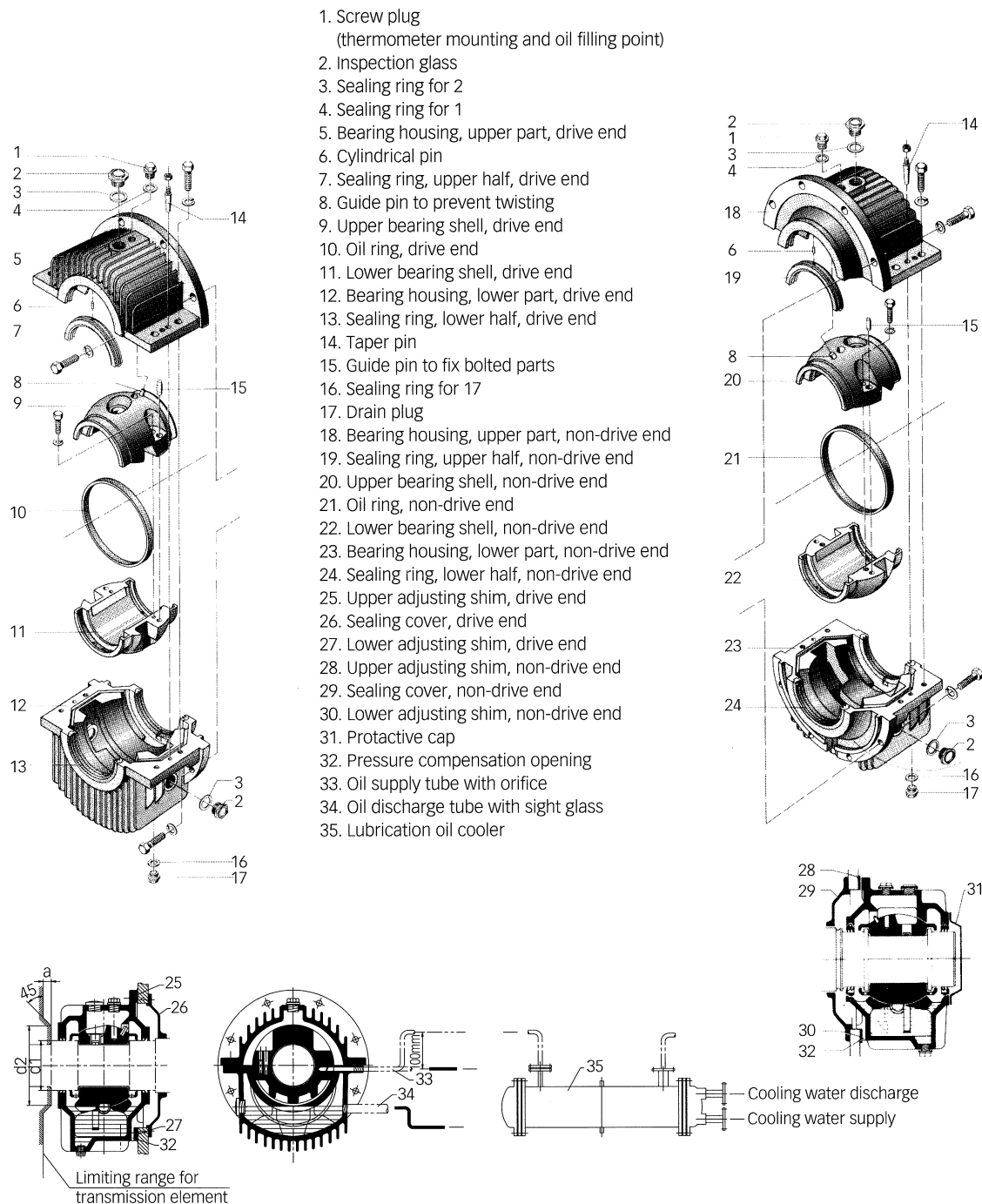
5) Lubrication oil cooler for generator bearings

Forced lubrication system may have lubrication oil cooler for technical reason.

Front and rear chambers of lubrication oil cooler can be disassembled in case of water leakage.

However, lubrication oil cooler do not need any overhaul works unless oil or water leakage happen because it requires additional compression test when those chambers are disassembled.

⇒ Fig. 27 Flange-type sleeve bearing for forced-oil lubrication (examples, delivered design may deviate in details)



d1 (mm)	80	100	120	150	180	215
d2 (mm)	140	160	170	190	210	245
a (mm)	8	8	10	15	18	22

3.4 Rolling-Contact Bearing (series 02 and 03)

1) Mounting

Electrical machines fitted with rolling-contact bearings mentioned above are subject to the following instructions supplementing and modifying the operating instructions of the machine:

The locating bearings are deep-groove ball bearings for horizontally mounted machines.

These bearings may also be in pairs with cylindrical roller bearings in the case of bearings is not guided radially and is prevented from rotating by compression springs.

The locating bearings for vertically mounted machines are angular-contact ball bearings of type range 72 or 73 (For angular-contact ball bearings with increased axial fixation, see supplementary operating instructions).

The floating bearings are deep-groove ball bearings or cylindrical roller bearings.

In the case of deep-groove ball bearings as floating bearings, the axial play is compensated by means of compression springs.

⚠ CAUTION

If the bearing temperature exceeds the normal operating value by 15 K, stop the machine immediately.
Inspect the bearing and determine the causes.
Setting values of a safety device
-Alarm: 100°C
-Trip: 105°C

2) Regreasing

⚠ NOTE

A common mistake is over-lubrication of bearings. When grease is added without removing the drain plug, the excess grease must go somewhere and usually it is forced into and through the inner bearing cap and is then thrown into the windings. Proper lubrication is desired, but some under-lubrication is less dangerous than over-lubrication.

Initial lubrication of the bearings is normally carried out in the works with an Alvania #2 grease satisfying the conditions of the running test at a test temperature of 120°C to DIN 51 806.

If a different type of grease is required, this is indicated on the data plate, provided that the particular operating conditions were given in the order.

⚠ CAUTION

Do not mix grease of different soapbases.
When changing the type of grease, clean the bearing beforehand using a brush with solvent.

⚠ NOTE

The most widely-used solvent is gasoline: white spirit is acceptable.

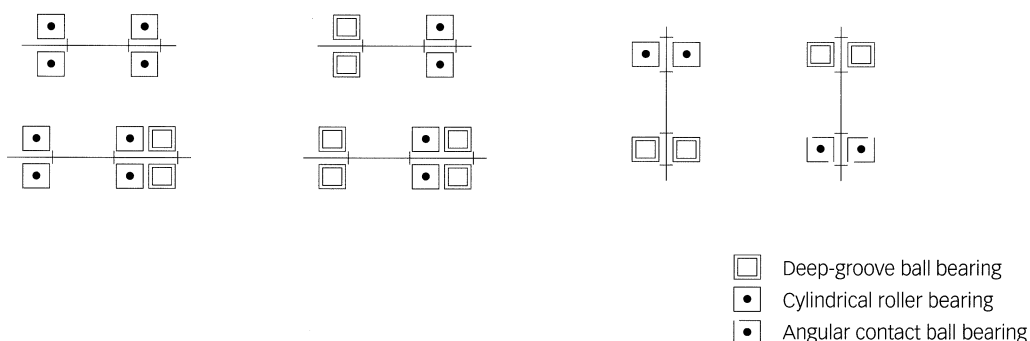
⚠ DANGER

The prohibited solvents are:
Chlorinated solvent (trichlorethylene, trichloroethane) which becomes acid.
Fuel-oil (evaporates too slowly).
Gasoline containing lead.
Benzine (toxic)

For regreasing, clean the lubricating nipple and press in the grease quantity indicated on a data plate, using a grease gun.

Keep the new grease meticulously clean.

⇒ Fig. 28 Examples for bearing combinations



The shaft should rotate during regreasing, hence the machines need not be stopped.

After regreasing, the bearing temperature will rise by a few degrees and will drop to the normal value when the grease has reached its normal service viscosity and the excess grease has been forced out of the bearing.

It is recommended that the lubricating instructions be strictly followed.

Special cases may require lubrication according to special instructions, e.g. where there is an extreme coolant temperature or aggressive vapours.

The old grease from several regreasing operations gathers in the space inside the outer bearings caps.
Remove the old grease when overhauling the machines.

The model of bearing is favorably chosen for direction and size of load (type of construction, forces acting on the shaft) and therefore it should not be hung.
The permissible values of axial and radial forces may be taken from the list of machine or may be inquired about.

The machines should operate in only one type of construction as shown on the rating plate, because another type of construction requires perhaps further measures in addition to a modification of the model of bearing.
In this case an inquiry is always necessary.

3) Lubrication

Regrease the bearings if the machines have been unused/stored for longer than 2 years.

4) Dismantling, assembling

For working on the locating bearing in the vertical position of the machine, support or discharge the rotor.

It is recommended that new rolling bearings be installed as follows: Heat the ball bearings or the inner ring of the roller bearings in oil or air to a temperature of approx 80 °C and slip them onto the shaft.
Heavy blows may damage the bearings and must be avoided.

When installing single angular-contact ball bearings, make sure that the broad shoulder of the inner ring (and the narrow shoulder of the outer ring) in operating position points upwards, i.e. in a direction opposite to that of the axial thrust.

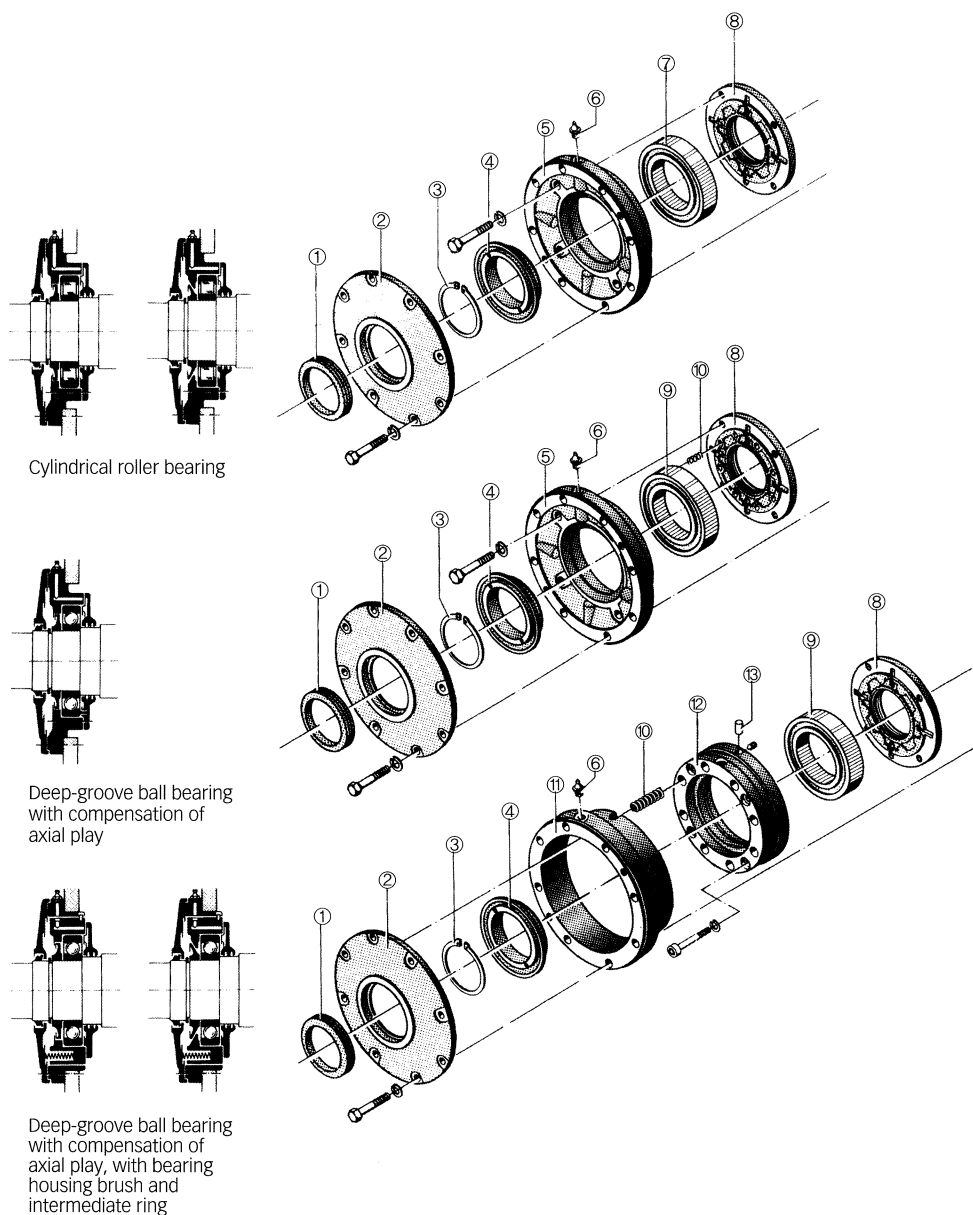
When assembling the machines, avoid damage to the sealing rings.
Rubber sealing rings (V-rings) should be carefully fitted over the shaft as shown the illustration.

New felt sealing rings should be so dimensioned that the shaft can run easily while proper sealing is still effected.
Before fitting new rings, soak them thoroughly in highly viscous oil (normal lubricating oil N68 to DIN 51 501) having a temperature of approx 80°C.

5) Locating faults

The trouble shooting table 4-6 helps to trace and remove the causes of faults as shown on page 53.
Sometimes, it is difficult to assess damage to the bearings. In this case, renew the bearings.

→ Fig. 29 Floating bearings (examples, delivered design may deviate in details)

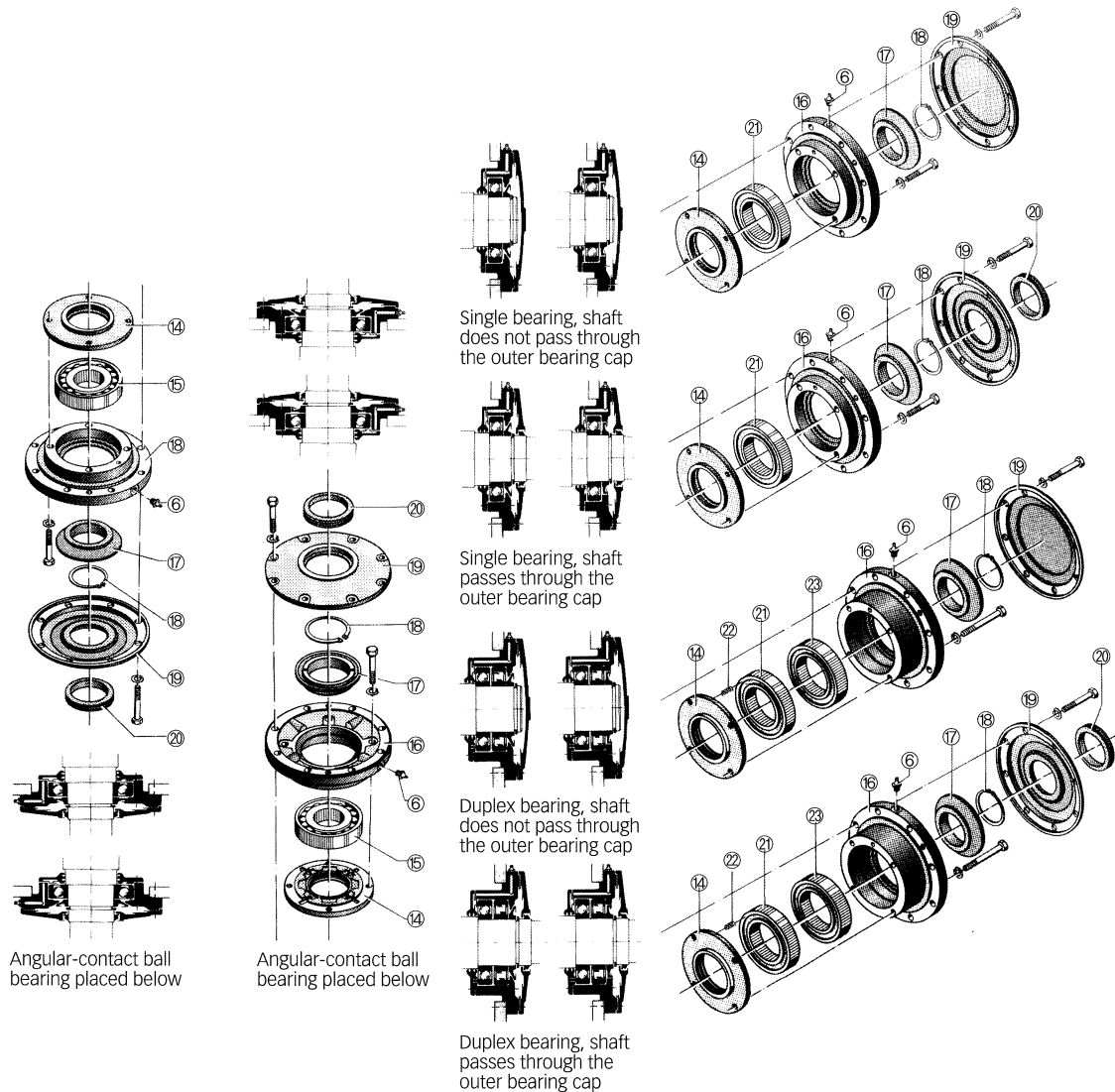


- ① V-ring ¹⁾
- ② Outer bearing cap ¹⁾
- ③ Circlip ¹⁾
- ④ Grease slinger ¹⁾
- ⑤ Bearing housing ¹⁾
- ⑥ Lubricating nipple
- ⑦ Cylindrical roller bearing ¹⁾
- ⑧ Inner bearing cap with felt sealing rings ¹⁾

- ⑨ Deep groove ball bearing (floating-bearing)
- ⑩ Compression spring ¹⁾
- ⑪ Bearing housing ring
- ⑫ Bearing housing brush
- ⑬ Cylindrical pin

¹⁾ floating bearing side

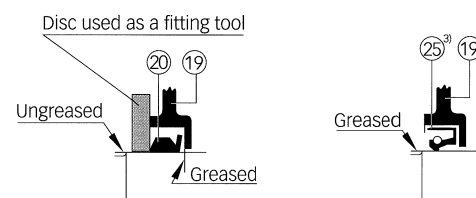
→ Fig. 30 Locating bearings (examples, delivered design may deviate in details)



- ⑥ Lubricating nipple
- ⑭ Inner bearing cap with felt sealing rings ²⁾
- ⑮ Angular-contact ball bearing
- ⑯ Bearing slinger ²⁾
- ⑰ Grease slinger ²⁾
- ⑱ Circlip ²⁾
- ⑲ Outer bearing cap ²⁾
- ⑳ V-ring ²⁾
- ㉑ Deep-groove ball bearing (locating bearing)
or angular-contact ball bearing
- ㉒ Compression spring ²⁾
- ㉓ Cylindrical roller bearing ²⁾
- ㉔ Cylindrical roller bearing ²⁾
- ㉕ Oil seal for shaft ^{1) 2) 3)}

- ¹⁾ floating bearing side
- ²⁾ locating bearing side
- ³⁾ special operating conditions only

→ Fig. 31 Fitting instructions for V-ring and oil seal for shaft



Single bearing, shaft does not pass through the outer bearing cap

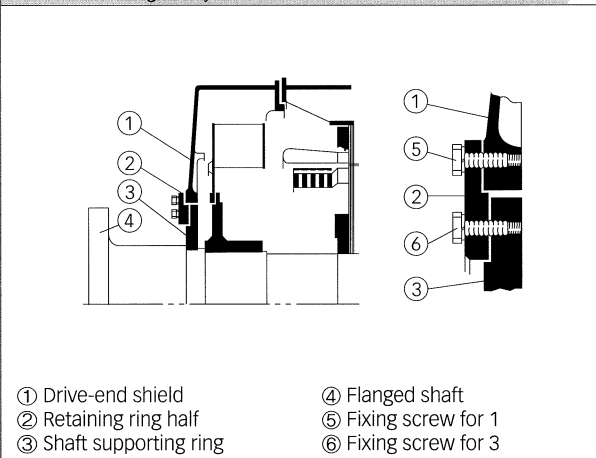
3.5 Coupling A-Type (single-bearing generators with flanged shaft and one-part fan wheel)

1) Transport

The following instructions supplementing and modifying the basic operating Instructions apply to single-bearing generators of type of construction B2 or B16 which are coupled with diesel engines or turbines:

For transport and assembly, the generator rotor is centered radially and fixed axially by means of bolted retaining-ring halves fitted between the drive-end shield (unsplit) and the shaft supporting ring (Fig. 32). The ring halves should therefore not be detached before the generator is assembled with the diesel engine or turbine.

⇒ Fig. 32 Rotor locking device (example, delivered design may deviate in details)



2) Aligning the coupling flanges (Fig. 33)

Careful alignment of the coupled machines prevents additional bearing and shaft stresses, as well as uneven and noisy running.

It is particularly important to achieve a uniform air gap. The machine shall be installed on a concrete foundation or a baseframe.

Check to see that the machine seating surfaces have been made in accordance with the drawings. The generator should be aligned with the diesel engine or the turbine with gearing (the prime mover should have already been installed and aligned in accordance with the manufacturer's instructions).

The generators are aligned and coupled as follows: Place the generator onto the concrete foundation or baseframe.

Insert shims underneath the mounting feet until the centering faces of the generator flange and engine (flywheel) or gear flange are in line with the flanges being parallel to each other.

Experience shows that less shims are required at the non-drive end than at the drive end, since the engine coupling flange is inclined by the weight of the flywheel. Bolt the coupling flanges together while re-pressing the generator axially, lightly tighten the foot bolts, and undo the retaining-ring halves.

3) Checking the air gap (Fig. 34)

Check the air gap between the shaft supporting ring and the drive-end shield.

The gap should be uniform all around.

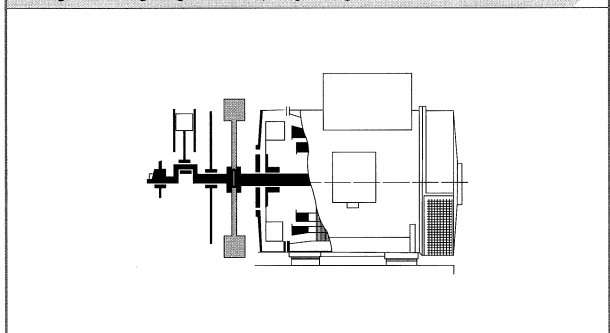
If the maximum difference between the measured values "a max-a min" exceeds 0.3 mm, correct the gap by inserting or removing shims underneath the mounting feet.

Experience indicates that the number of shims to be inserted or removed at the non-drive end is only 50% of the number at the drive end.

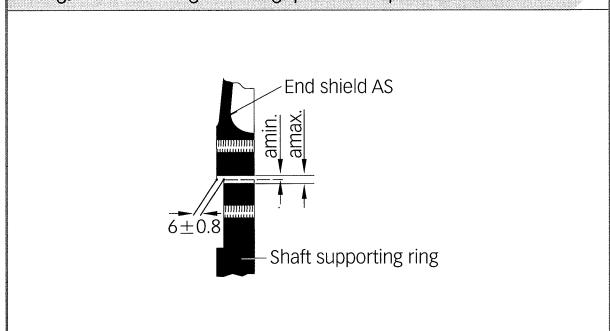
Tighten the holding-down bolts and check the web clearance of the diesel engine.

It may be necessary to correct the air gap and the web clearance several times.

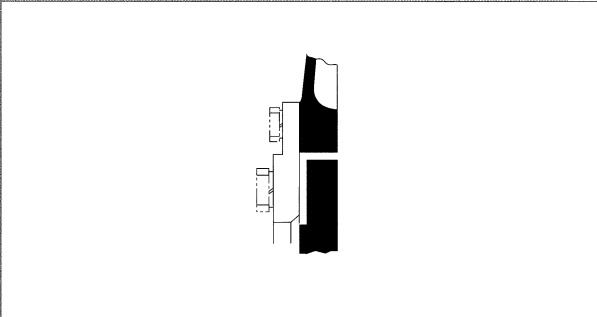
⇒ Fig. 33 Aligning the coupling flanges



⇒ Fig. 34 Checking the air gap and the position of the rotor



➔ Fig. 35 Fixing of the retaining-ring halves after assembling with prime mover



4) Position of rotor in longitudinal direction (Fig. 34)

Originally, the generator rotor had been located axially in the correct position by the bolted-on retaining-ring halves.

Since single-bearing generators have a floating (rolling or sleeve) bearing at the non-drive end, the axial position of the rotor may have been changed during alignment.

A check should therefore be made to ensure that the axial clearance of (6 ± 0.8) mm between the flange faces of the drive-end shield and the shaft supporting ring has been maintained.

Otherwise the stator frame should be shifted axially.

5) Fixing the retaining-ring halves

Thereupon, screw the retaining-ring halves to the drive-end shield as shown in Fig. 35.

The ring joint should be vertical.

Close off the threaded holes in the retaining-ring halves by means of the screws supplied, and lock the screws with spring washers.

3.6 Coupling B-Type (single-bearing generators with lamination plate)

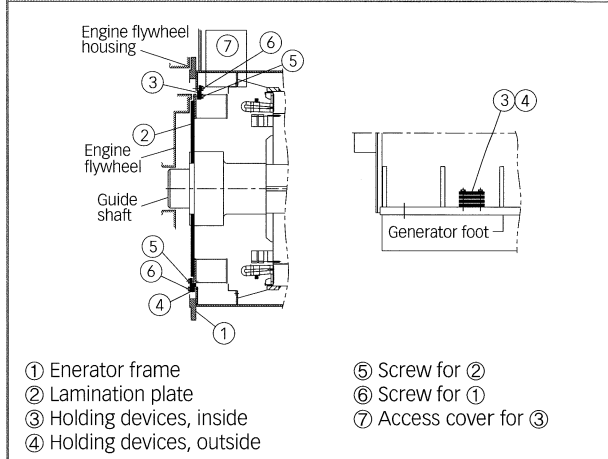
1) Transport

The following instructions apply to the generators coupled with engine using lamination type coupling.

For transportation and assembly, the generator rotor is centered radially and fixed axially by means of the holding devices fitted between generator frame and lamination plates or fan assembled (Fig. 36).

Therefore, those holding devices must be fixed tightly inner and outer sides for sure when transport. This is for centering the generator rotor radially and axially.

➔ Fig. 36 Rotor locking device (example, delivered design may deviate in details)



2) Aligning the lamination plate coupling (Fig. 36)

Careful alignment of coupled machines prevents additional bearing and shaft stresses as well as uneven and noisy running. It is particularly important to achieve a uniform air gap. The machine may be installed on a concrete foundation or a base frame.

Check to see that the machine seating surfaces have been made in accordance with the diesel engine (the prime mover should have already been installed and aligned in accordance with the manufacturer's instructions).

The generators are aligned and coupled as follows:

Place the generator onto the concrete foundation or base frame. Align the mounting feet until the centering faces of the generator side and engine flywheel and its housing are in line with lamination plates being parallel to each other.

When coupling the generator with the engine, the outer holding devices (No. 4) shall be removed before inserting generator guide shaft to flywheel. After inserting the shaft, inner holding device (No. 3) shall be removed and further coupling works carried out in accordance with standard instructions of the engine maker.

For reference, this type of coupling does not need shim plate under the generator.

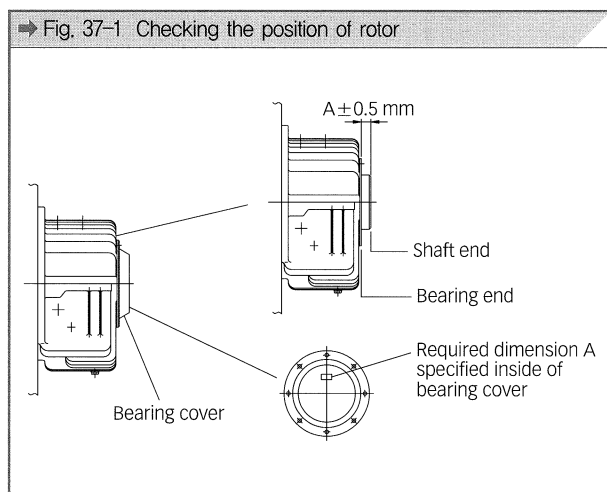
Removed holding devices shall be stored on generator foot after coupling for the future transportation or repairing works.

3) Checking the air gap

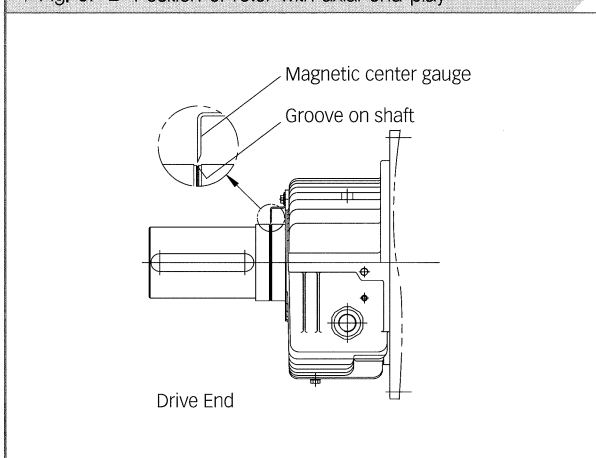
This type of coupling does not need to check air gap because engine flywheel housing/ generator frame and engine flywheel/ generator rotor are directly coupled.

4) Position of rotor in longitudinal direction (Fig. 37-1)

After generator is completely coupled, position of rotor shall be checked in longitudinal direction by opening the bearing cover and comparing the measurement with the value, A specified inside of the cover as shown on Fig. 37-1. This value has been marked at the factory as required to be kept when coupled with the engine considering bearing gap measured.



⇒ Fig. 37-2 Position of rotor with axial end play



3.8 Air Filters

1) Air filter cleaning period

The cleaning period depends on the site conditions. The cleaning of the filter is requested if the record of the stator winding temperature (using the stator winding sensors) indicates an abnormal increase in temperature.

2) Air filter cleaning procedure

The filter element (flat or cylindrical) is immersed in a tank of cold or warm water (temperature less than 50°C). Use water with detergent added. Shake the filter gently to ensure that the water flows through the filter in both directions.

When the filter is clean, rinse it with clear water. Drain the filter properly (there must be no more formation of droplets).

Refit the filter on the machine.

⚠ CAUTION

Do not use water with a temperature higher than 50°C.
Do not use solvents.

Do not clean the filter using compressed air. This procedure would reduce filter efficiency.

3.7 Coupling (double bearing generator)

1) Fitting the coupling element

The coupling element must be balanced separately before fitting the machine shaft.

A residual unbalance of coupling element should be less than class G 2.5 grade to ISO standard.

2) Without axial end play at bearing

The alignment must take the tolerance of the coupling element into account.

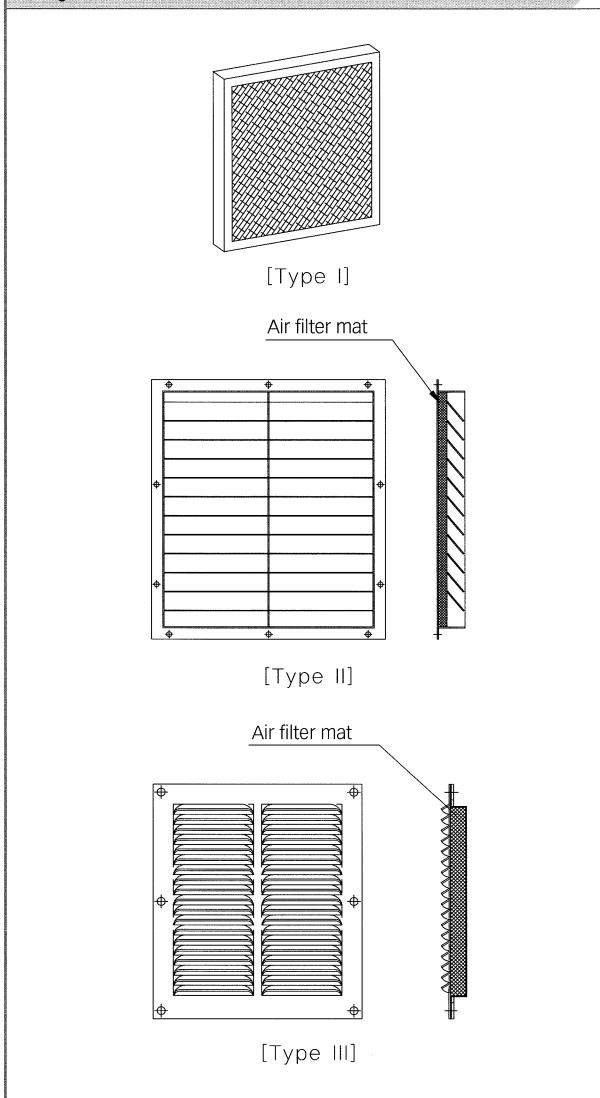
The axial, radial and angle tolerance are to be acceptable by coupling element property.

3) With axial end play at bearing (Fig. 37-2)

In this case, the axial position of the rotor assembly was adjusted during the initial test at the factory.

The generators are delivered with a magnetic center gauge at the drive bearing side with a groove on the shaft and must be kept in the rotor position during the alignment with the prime mover as shown on Fig. 37-2.

⇒ Fig. 38 Installation for air filter



See terminal box diagram in the final specification.

The openings provide access to the terminals.

The gland plates are made of non-magnetic materials in order to avoid circulating currents if needed.

Compare the supply voltage with the data on the rating plate. Connect the supply leads and the links in accordance with the circuit diagram in the final specification.

Pay attention to the right direction of rotation (phase sequence in the case of three phase and polarity in the case of direct current).

The supply leads should be matched to the rated current in line with VDE0100 and their cross section must not be excessive.

The main circuit is normally connected at both sides of the circuit bars with conductor cross sections of max. 300 mm² and may be made by cable lugs or when connecting parts used in hazardous locations which are present without any lugs.

The ends of the conductors should be stripped in such a way that the remaining insulation almost reaches up to the lug or terminal (≤ 5 mm).

In the case of cable lugs with long sleeves, it may be necessary to insulate the latter to maintain the proper clearances in air.

If using cable lugs, see that the dimension of the cable lugs and its fastening elements (normally M12) agree with the holes in the copper bus bar.

Use hexagon-head screws with a min. breaking point of 500 N/mm², hexagon nuts and spring elements which are protected against corrosion according to DIN 43673.

3.9 Terminal Box



High voltage

Power source must be disconnected before working on equipment.
Failure to disconnect power source could result in injury or death.
Terminal box only to be opened by skilled personnel.

1) Description

Use the attached terminal box drawing in the final specification.

The main terminal box of the machine is located on the top of the machine.

The neutral and phase wires are connected to the copper bus bar-one copper bus bar per phase and one copper bus bar per neutral line (option).

The connection of accessories is achieved by terminal strips.

Use a 5 mm maximum screwdriver to work on the blocking screws.

See the terminal connection diagram in the final specification.

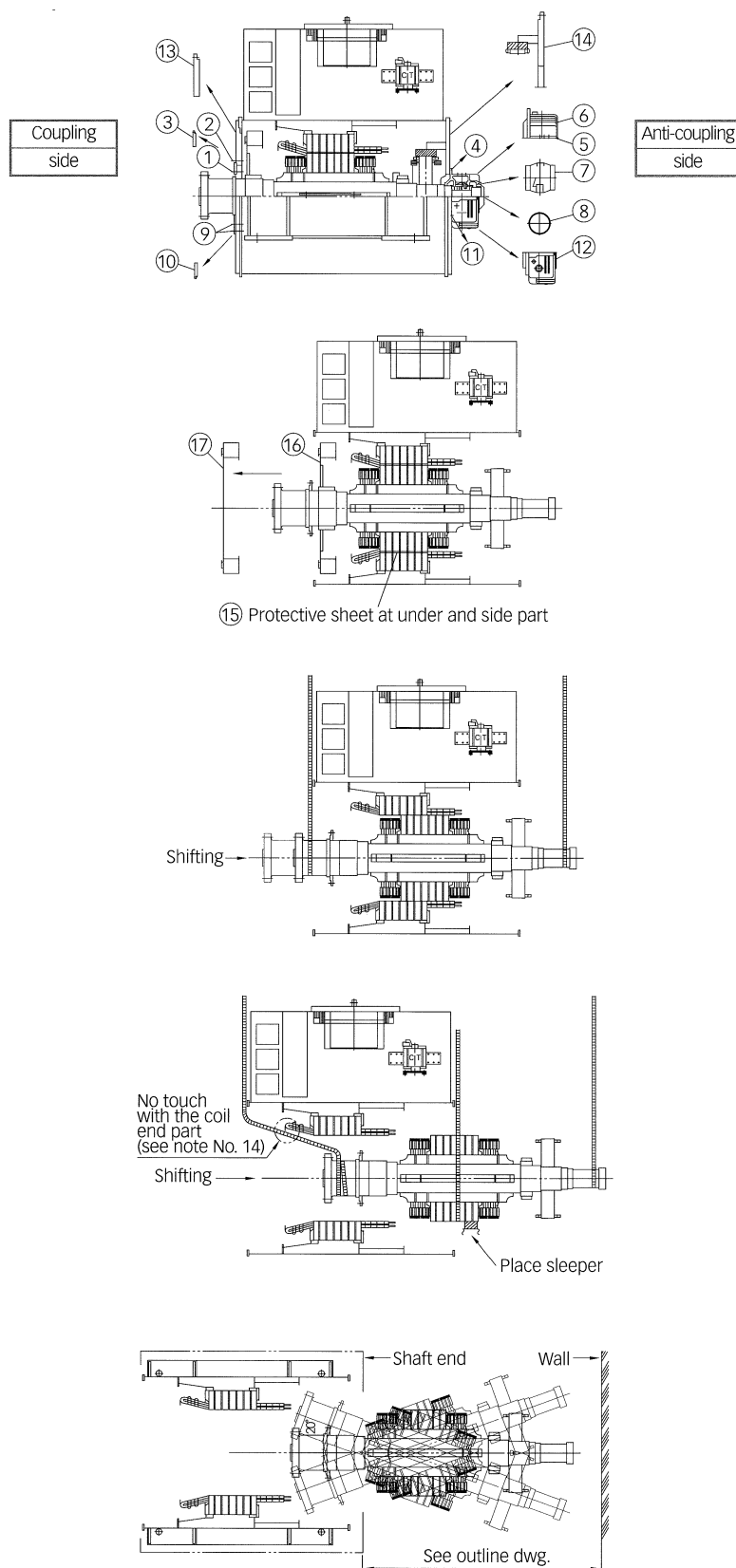
The supply leads – particularly the protective conductor – should be laid loosely in the terminal box with an extra length for protecting the cable insulation against splitting and to prevent the terminals and circuit bars from the tension load of the leads.

They should be introduced into the terminal box through cable entry fittings and sealed.

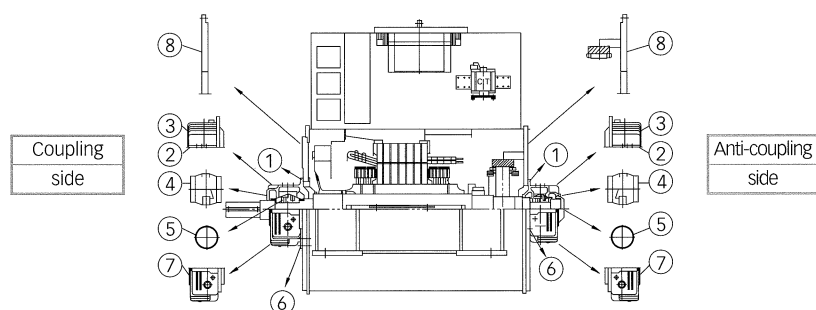
Protected fittings with strain – relief cleats should be used for loose leads to prevent them from becoming twisted. Close off any unused cable-entry openings.

3.10 Disassembly of A.C. Generator (Fig. 39, 40 and 41)

→ Fig. 39 For single bearing type A.C. generator

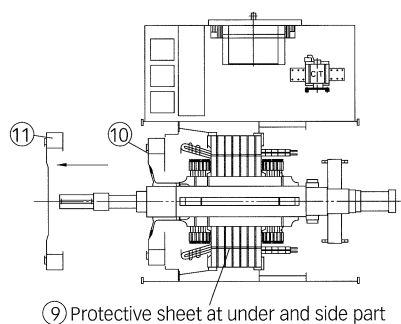


⇒ Fig. 40 For double bearing type A.C. generator



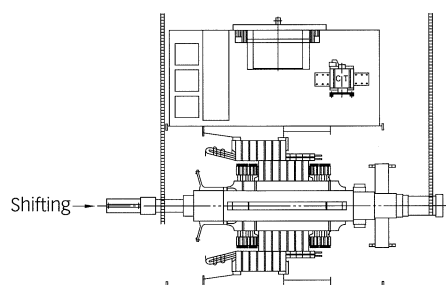
{ I }

1. Take away bolts ①
2. Take away bolts ②
3. Take away bearing upper part ③
4. Take away bearing shell ④ and oil ring ⑤
5. Take away bolts ⑥ and bearing under part ⑦
6. Take away endshield ⑧



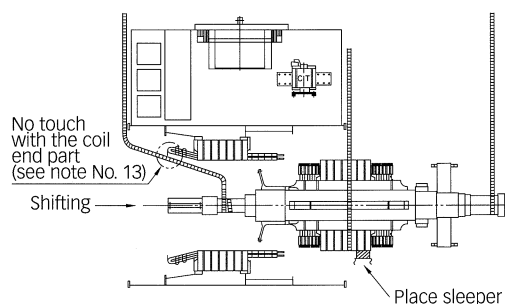
{ II }

7. Insert protective sheet ⑨
8. Take away bolts ⑩
9. Draw out fan ⑪



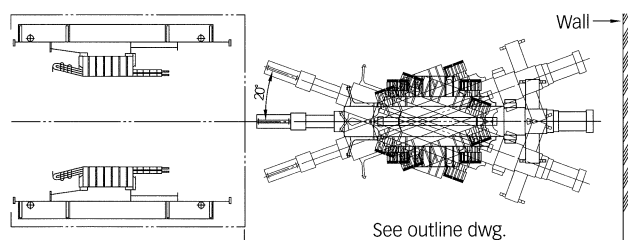
{ III }

10. Hang the shaft end with rope both side.
(shaft journal should be protected from any damages by wrapping in cloth)
11. Shift the rotor toward anti-coupling side.



{ IV }

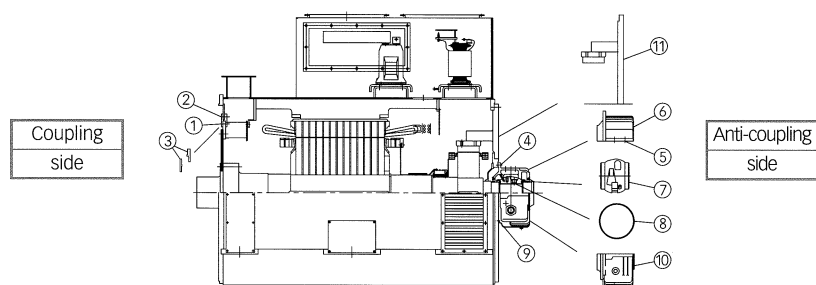
12. Shift the rotor assembly to anti-coupling side as left description.
13. Hang the rotor assembly at its center position by the rope.
14. Take away the rope of coupling side.



{ V }

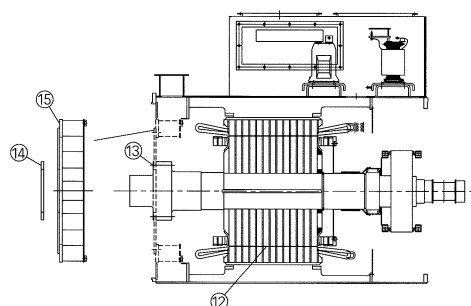
15. Take away the rotor out of the stator.

⇒ Fig. 41 For single bearing with laminated plate type A.C. generator



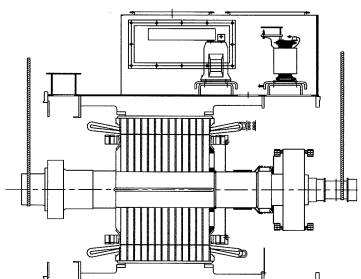
{ I }

1. Take away bolts ①, ②
2. Take away support pieces ③
3. Take away bolts ④, ⑤
4. Take away bearing upper parts ⑥
5. Take away bearing shell ⑦ and oil ring ⑧
6. Take away bolts ⑨ and bearing under part ⑩
7. Take away end shield ⑪



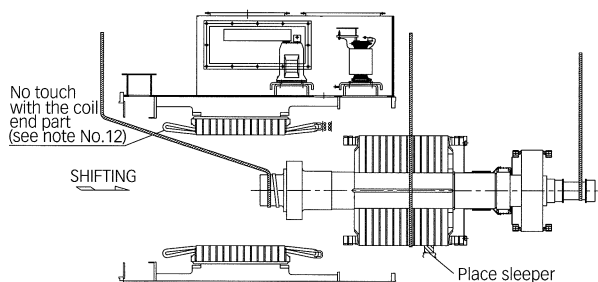
{ II }

8. Insert protective sheet ⑫
9. Take away bolts ⑬
10. Draw out support ring and fan ⑭, ⑮



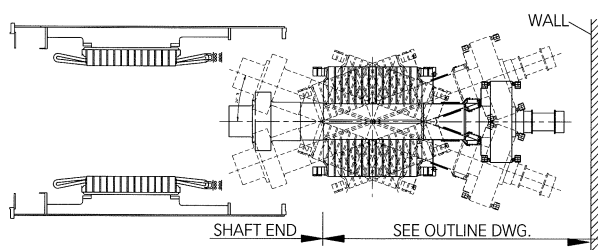
{ III }

11. Hang the shaft end with rope both side.
12. Shift the rotor toward anti-coupling side.
(shaft journal should be protected from any damage by wrapping in cloth)



{ IV }

13. Shift the rotor assembly to anti-coupling side as left description.
14. Hang the rotor assembly at its center position by the rope.
Take away the rope of coupling.



{ V }

15. Take away the rotor out of the stator.

3.11 Cooler

1) General points

The purpose of the cooler is to remove machine heat losses (mechanical, ohmic etc).

The exchanger is located on the top of the machine.

Normal operation:

The air is pulsed by a fan fixed to the synchronous machine shaft.

Description of air-water double tube exchanger

The double-tube technique keeps the cooling circuit from being affected by possible water leakage.

The double tube provides a high safety level.

In case of leakage, the water goes from the inside of the internal tube to the coaxial space between the two tubes.

The water is drained axially to a leakage chamber where it may activate a sensor.

An exchanger comprises a fin-tube block containing:

- a steel frame.
- a fin-tube block expanded mechanically to the tubes.

The tube bundle is roll-expanded in the end plates.

The water distribution in the tubes is provided by two removable water boxes.

A water box is equipped with collars for fitting the inlet and outlet lines.

Neoprene seals ensure water tightness between the water boxes and the end plates.

2) Cleaning

The frequency of cleaning operations depends essentially on the purity of the water used.

We recommend to inspect annually at least.

The life of zinc block for anti-corrosion is about a year.

Therefore, replace it with a new one every year.

Cut off the water supply by isolating the inlet and outlet lines, and drain the water.

Disconnect the leak sensor (option with double-tube cooler), and make sure that there are no leaks.

Remove the water boxes on each side of the machine.

Rinse and brush each water box.



NOTE

Do not use a hard wire brush as this will remove the protective tar-epoxy layer which has formed on the surfaces of the water boxes.

Clean each tube with a metal scraper.

Rinse in soft water.

Keep the leakage chamber dry (double-tube water-cooler only)

3) Stop the machine

Leak detection for a double-tube exchanger:

If a leak is detected, cut off the power supply of the water in/outlet lines and change to emergency operations according to Fig. 45, 47, 49 immediately.

The problem must be ascertained and repaired.

Remove the two water boxes, apply a slight positive pressure in the leakage chamber and between the two tubes (only concerns double-tue coolers).

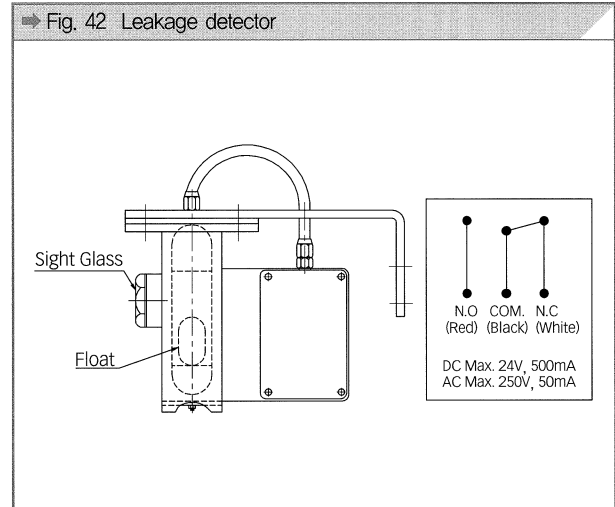
If a tube is damaged, plug it at both ends.

Use a tapered plug.

Preferably the plug should be made of salt-water resistant aluminium bronze or a synthetic material.

4) Leak detection (float system)

A magnet float activates a switch located in the float case.



5) Cooler removal

The cooler unit is slid into its housing.

It is possible to remove the cooler from the housing without removing the water boxes as shown in Fig. 43.

The cooler is fastened to the housing via a series of screws on the housing.

Remove the water supply and return pipes.

Provide two eye-bolts to hold the cooler when it comes out of its housing.

Remove the cooler using slings that can be attached to the connecting flanges.

6) Cooler re-assembly

Carry out the operations of the "Cooler Removal" Fig. 43 in the reverse order. Be careful to push the cooler completely into its housing before tightening the fastening screws of the cooler to the casing.

3.12 Cooling-Water Failure Emergency Operation

1) HFJ 5, 7 & HSJ 7 Type

(1) Changing over to open-circuit cooling

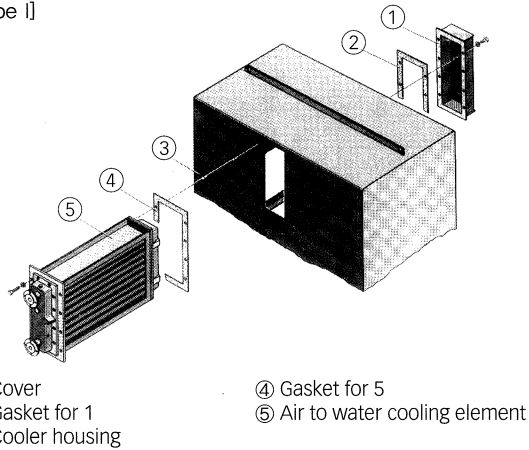
Generators have a facility for emergency operation if the cooling water supply fails.

The following supplements the machine description and the module for the closed-circuit cooling.

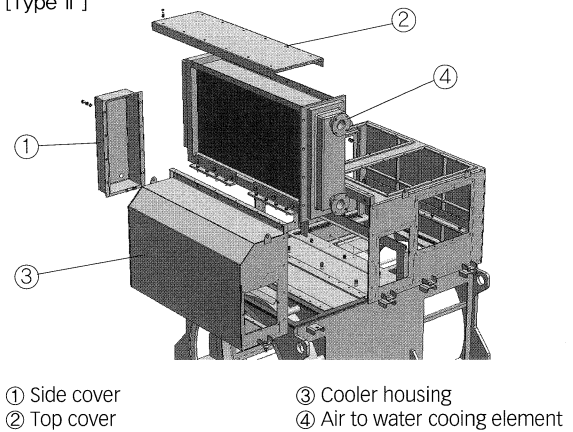
Should the cooling water supply fails, the machine can be changed over to an open cooling circuit (Fig. 45), as follows:

⇒ Fig. 43 Cooler removal

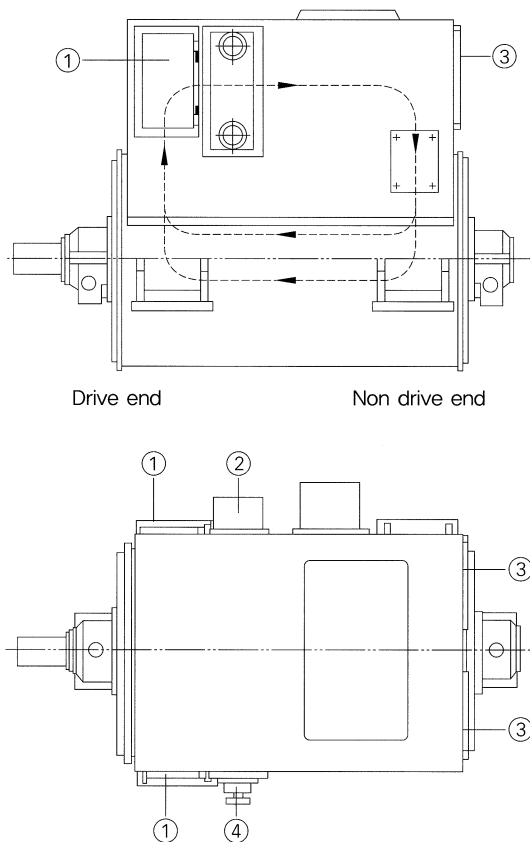
[Type I]



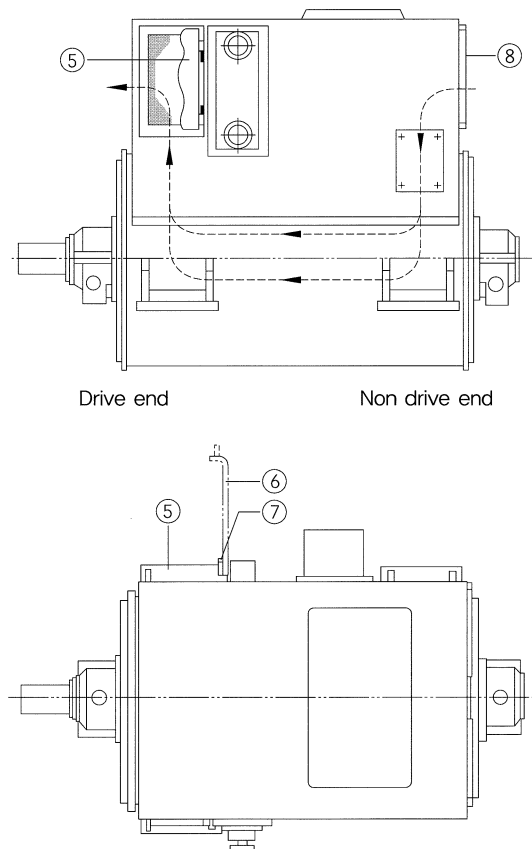
[Type II]



⇒ Fig. 44 Normal operation with air-to-water closed-circuit cooling



⇒ Fig. 45 Emergency operation with open cooling circuit following failure of the cooling water supply



The electrical version of the alternator remains unchanged.

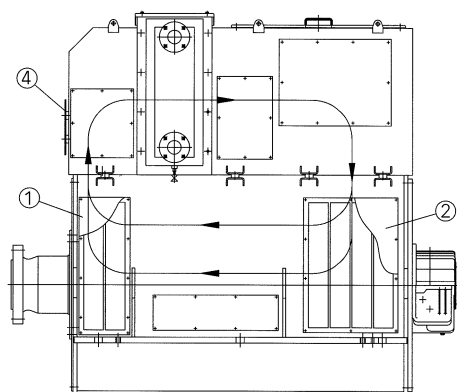
[Type I]

- Open the air vents at the non drive end for the air inlet and at the drive end for the air outlet (Figs. 44 and 45 - No. 3 & 5),
- Remove enclosure or cover 2 (Fig. 44)
- Insert air cut-off plate 6 (Fig. 45) into the slot in the raised section on the housing on the hot air side of the cooler and secure.

[Type II]

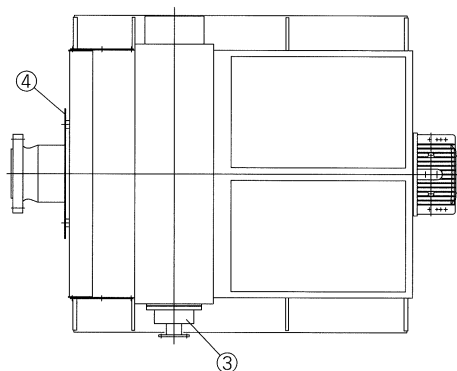
- Open the air vents at the drive end for air inlet and at the non drive end for air outlet (Fig. 46, No. 1 & 2)
- Remove the access cover (Fig. 47, No. 7)
- Insert air cut-off plate (No. 4) and secure inside of cooler housing

⇒ Fig. 46 Normal operation with air-to-water closed-circuit cooling



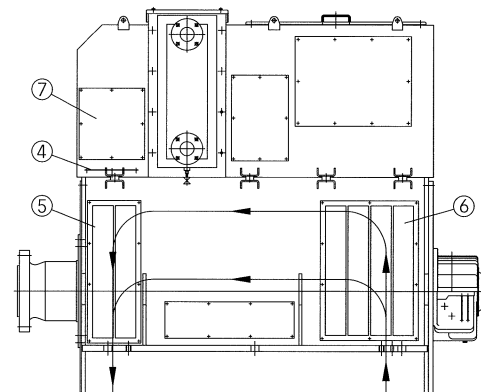
Drive end

Non drive end



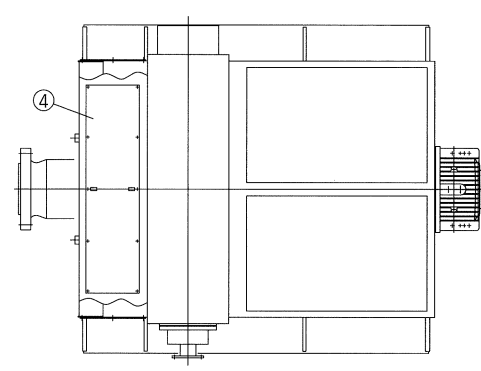
- ① Air vent with cover, closed
- ② Air vent with cover, closed
- ③ Air-to-water cooler
- ④ Air cut-off plate

⇒ Fig. 47 Emergency operation with open cooling circuit following failure of the cooling water supply



Drive end

Non drive end



- ⑤ Air vent, open
- ⑥ Air vent, open
- ⑦ Access cover for ④

2) HFJ 6, 7 & HSJ 7 Type

(1) Changing over to open-circuit cooling

On failure of the cooling-water flow, the following operations are required to convert the generator for emergency operation with open cooling.

The electrical version of the generator remains unchanged.

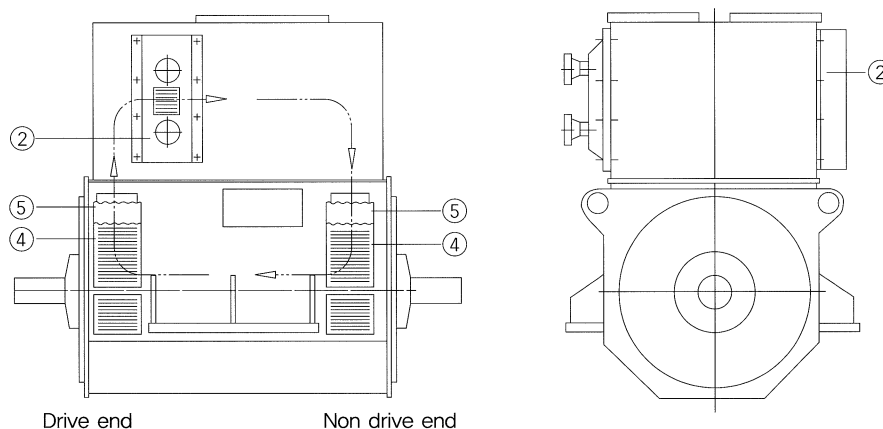
- Detach louvered covers (No. 4) together with the closure plates (No. 5) at the drive and non drive ends, remove closure plates and attach louvered covers in their original positions (Fig. 48).

- Detach the cover (No. 2) from the opposite side the cooling water connections, insert the air-stop plate (No. 3) and secure with the screws provided.

(2) Changing over to closed-circuit cooling

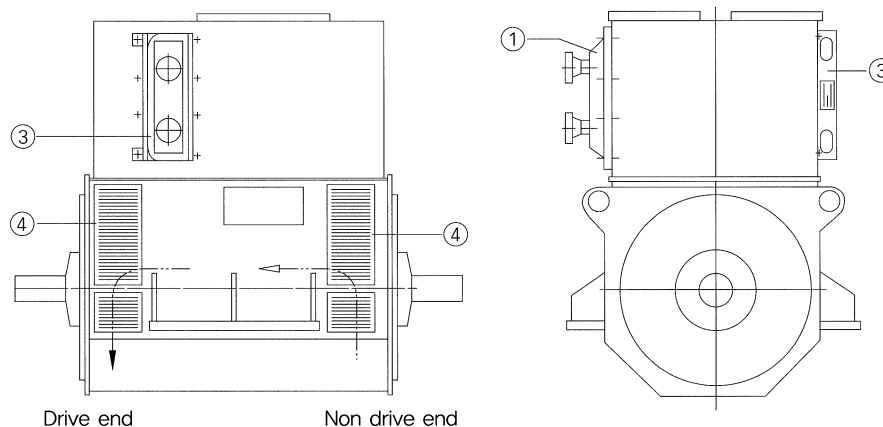
Operation should be changed back from emergency to normal operation with air-to-water closed-circuit cooling as soon as possible in the reverse sequence described above.

⇒ Fig. 48 Normal operation with air-to-water closed-circuit cooling



- ② Cover for No 1.
- ④ Louvered cover (emergency operation).
- ⑤ Closure plate.

⇒ Fig. 49 Emergency operation with open cooling circuit following failure of the cooling water supply



- ① Air-to-water cooling element.
- ③ Air-stop plate (emergency operation).
- ④ Louvered cover (emergency operation).

4.1 Excitation Part for SPRESY 15

In the case of faults, it is advisable to check the voltage controller, excitation equipment, and main machine with an exciter separately.

For troubleshooting in the thyristor voltage controller, all the leads connecting excitation equipment and thyristor voltage controller must be disconnected, and if present, the intermediate transformers of the droop-compensating equipment secondaries short-circuited.

In this case, the generator voltage must rise above the maximum reference value as given under "Description". In this case, the thyristor voltage controller is defective. Troubleshooting should be continued according to Table 4-2.



DANGER

Hazardous voltage

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

If the voltage is not induced, either the excitation equipment, the main machine or the exciter can be defective. Troubleshoot according to Table 4-4. Information concerning voltage values for the thyristor regulator module is given overleaf and assists in the location of faults.

⇒ Table 4-1. Excitation part				
Terminal 20-14	< 30 V		> 30 V	
Terminal 15-14	about 1 V	about 10 V	about 1 V	about 10 V
Fault location (Fig. 14)	Regulator module	Firing module	Firing module	Regulator module

If the remnant should not be adequate for exciting the generator, a D.C. voltage (6 to 24 V) must be connected to terminals F1 and F2 (+ to F1, - to F2) for a short time. Please note that the terminals F1 and F2 start carrying a voltage as soon as self-excitation sets in. When ordering spare parts please, state the type and serial number of the generator, as they are shown on the rating plate.

4.2 Excitation Part for 6 GA 2491



DANGER

Hazardous voltage

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

Troubleshooting shall be carried out according to Table 4-3.

4.3 Main Machines and Exciters (HF. 5 and 6)

**DANGER****Hazardous voltage**

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

⇒ Table 4-4. Fault diagnosis chart for excitation equipments, main machines and exciters

Cause			Electric fault symptoms	Genetator excitation fails	Voltage deviates from rated value		Too warm						Defective rectifier
							Main machine		Exciter		Transformer	Reactor	
					No load follo- wing load duty	On-load conditions	Stator winding	Rotor winding	Stator winding	Rotor winding			
Incorrect service conditions or duty under conditions deviating from order specifications	Overload				●	●	●	●	●	●		●	
	Speed deviating from set point		●	●	●								
	Excessive deviation from rated power factor				●		●	●	●	●		●	
	Incorrect operation, e.g.paralleling with 2nd generator in phase opposition											●	
Inter-turn fault	Main machine	Stator	●	●	●								
		Rotor	●	●	●								
	Exciter	Stator	●	●	●								
		Rotor	●	●	●								
Winding discontinuity	Main machine	Stator	●	●	●								
		Rotor	●										
	Exciter	Stator	●										
		Rotor	●										
Defective rotating rectifier			●	●	●								
No remanence			●										
Faults on excitation equipment	Transformer	Inter-turn fault	●	●	●								
		Winding discontinuity	●	●	●								
	Single-phase current transformer	Inter-turn fault	●	●	●								
		Winding discontinuity			●								
	Reactor	Inter-turn fault	●	●	●						●		
		Winding discontinuity	●	●	●								
	Capacitor	Open or short circuit	●	●	●								
	Defective rectifier		●	●	●								

4.4 Bearing Part



Hazardous voltage

Will cause death, serious injury, electrocution or property damage.

Disconnect all power before working on this equipment.

⇒ Table 4-5. Sleeve bearing

Possible cause	Defects					Remedy
	Bearing overheats	Bearing leaks	Oil in machine	Oil discolours quickly	Large temperature variations	
Oil aged or dirty	●				●	Clean bearing housing; renew oil
Oil ring does not rotate evenly	●			●	●	Straighten and deburr the ring or renew it
Excessive axial thrust or radial load	●			●		Check alignment and coupling
Too little crest clearance 1)	●			●		Rescrape bearing surface
Oil grooves too small or not wedge-shaped	●			●		Refinish the oil grooves
Oil viscosity too high	●					Check Viscosity; change oil
Oil viscosity too low				●	●	
Defective bearing surface				●	●	Renew lining
Defective seals		●				Renew seals
Incorrect oil discharge from sealing rings		●				Clean return openings and grooves
Bearing too cold during start-up		●		●		Preheat the bearing or oil
Gap between sealing cover and shaft too large			●			Bush or replace the cover
Pressure compensation opening clogged			●			Clean compensation opening
Forced-lubrication system failure	●			●		Inspect system
Oil flow too high		●				Readjust the flow rate; check oil discharge

1) Crest clearance = Inside diameter of bearing shells minus diameter of shaft.

⇒ Table 4-6. Roller bearing

Possible cause	Defects			Remedy
	Bearing overheats	Bearing leaks	Oil in machine	
Felt sealing rings pressing on shaft	●			Fit rings better into grooves or replace them
Strain applied from coupling	●			Improve alignment of machine
Excessive belt tension	●			Reduce belt tension
Bearing contaminated	●			Clean or renew bearing, inspect seals
Ambient temperature higher than 40°C	●			Use special high-temperature grease
Lubrication insufficient	●	●		Lubricate according to instructions
Bearing canted	●	●		Check mounting conditions, install outer ring with lighter fit
Too little bearing play	●	●		Fit bearing with larger play
Bearing corroded	●	●		Renew bearing, inspect seals
Scratches on raceways			●	Renew bearing
Scoring			●	Renew bearing, avoid vibration while at a standstill
Excessive bearing play			●	Install bearing with smaller play

4.5 Operating Procedure & Check Sheet for Trouble Shooting



Hazardous voltage
Will cause death, serious injury, electrocution or property damage.
Disconnect all power before working on this equipment.

1) Single running

- ① Start No.1 Engine at its rated speed.
- ② Adjust No.1 generator voltage to its rated value at no-load using reference value setter (V.R), which is mounted on control panel side. After adjusting the voltage to its rated value, check the generator voltage using a digital tester at switch board side.
- ③ Repeat ① and ② of 4.5 1) for No. 2, No. 3 and No. 4 generators.
- ④ After completion of the no-load setting, read the indicated value on the panel and record the results according to Table 4-7.
- ⑤ Circuit breaker 'ON'.
- ⑥ Increase the load constantly from zero (0) to a rated load (as much as possible) and record the results according to Table 4-8.
- ⑦ Repeat ⑤ and ⑥ of 4.5 1) for No. 2, No. 3 and No. 4 generators.
- ⑧ In general, the droop compensating method is used for our generators for parallel running.
Generator voltage should be dropped in proportion to the magnitude of the load.

Examples)

- Full load zero (0) power factor = 4% droop.
- Full load rated power factor (0.8 P.F) = 2.4% droop.
- Unit power factor (1.0 P.F) = Generator voltage is not dropped.

2) Parallel running (for manual synchronizing)

- ① After load testing of each generator, start No. 1 single running and proceed to items ①, ②, ③, ⑤ and ⑥ of 4.5 1)
- ② If the synchro scope indicates a synchronized position, insert the No. 2 circuit breaker carefully.



If synchronization fails, the generator can be damaged by a transient current.
Please refer to synchronizing instructions of the switch board maker.

- ③ Increase the load constantly from zero (0) to a rated load.
- ④ Record the results according to Table 4-9.



- A. Parallel running of No. 3 and No. 4 generator:
The method is the same as No. 1 & No. 2.
- B. If the power factor and KVAR are unbalanced after completion above the procedure, consult the generator manufacturer using Table 4-9.

→ Table 4-7. Single running

Item \ Ship No.	No. 1	No. 2	No. 3	No. 4	Notes
R.P.M. or Hz					
Voltage					

※ After match the no-load voltage of each generator, don't adjust generator voltage (before, during and after parallel running)

→ Table 4-8. Single running

Item \ Ship No.	kW	Volt (V)	R.P.M. (Hz)	Current (A)	Power Factor	Notes
EACH GEN. (No. 1, 2...)						

→ Table 4-9. Parallel running

Item \ Ship No.	kW	Volt (V)	R.P.M. (Hz)	Current (A)	Power Factor	Notes
No.1 & No.2,	/			/	/	
No.1 & No.3,	/			/	/	
No.1 & No.4,	/			/	/	
each condition.	/			/	/	
No.1,	, , ,			, , ,	, , ,	
No.2,	, , ,			, , ,	, , ,	
No.3 & No.4,	, , ,			, , ,	, , ,	
	, , ,			, , ,	, , ,	

Memo

www.hyundai-elec.com



ELECTRO ELECTRIC SYSTEMS

Head Office	1 Jeonha-dong, Dong-gu, Ulsan, Korea Tel. 82-52-202-6601~9 Fax. 82-52-202-6995
Seoul (Sales & Marketing)	140-2, Gye-dong, Jongno-gu, Seoul, Korea Tel. 82-2-746-7538, 7583 Fax. 82-2-746-7679
Orlando	3452 Lake Lynda Drive, Suite 170, Orlando, Florida 32817 U.S.A. Tel. 1-407-249-7350 Fax. 1-407-275-4940
London	2nd Floor, The Triangle, 5-17 Hammersmith Grove London, W6 0LG, UK Tel. 44-20-8741-0501 Fax. 44-20-8741-5620
Tokyo	8th Fl., Yurakucho Denki Bldg.1-7-1, Yuraku-cho, Chiyoda-gu, Tokyo 100-0006, Japan Tel. 81-3-3212-2076, 3215-7159 Fax. 81-3-3211-2093
Dubai	Room 6206, Al Bustan Centre Al Qusais P.O.Box 252458 Dubai, U.A.E. Tel. 971-4-263-9071 Fax. 971-4-263-9072
Sofia	1271, Sofia 41, Rojen Blvd, Bulgaria Tel. 359-2-803-3200, 3220 Fax. 359-2-803-3203
Yangzhong	Lianzhong Avenue, Xinba Scientific and Technologic Zone, Yangzhong City, Jiangsu 212212, China Tel. 86 511 842 0666 0500 Fax. 86 511 842 0668 0224

**SHOP TEST RESULT
FOR
D / G ENGINE**

Engine No.	BA2768
Engine Type	5H21/32
Hull No.	YANGFAN2003
Owner	TB MARINE
Class	ABS
Ship yard	YANGFAN SHIPYARD



Hi-Touch and Hi-Tech Medium Speed Engine

CONTENTS

PAGE NO.

1. Spec. of Engine & Accessory	1
2. Measuring Record(Load test)	2~4
3. Setting Table	5~7
4. Governor & Parallel running test record	8
5. Mechanical vibration measurement	9
6. Height of resilient support	10
7. Calculation sheet of F.O	11

QUALITY MANAGEMENT DEPARTMENT

HHI-EMD

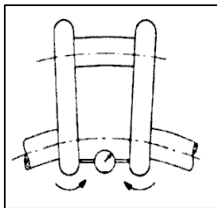
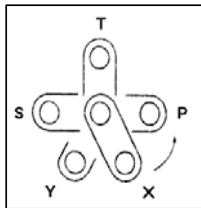
Rev.	Prepared	Checked	Approved	Description
2				
1				
0	H. B. JEON 2008-10-21	M. H. KIM 2008-10-21	Y. S. LEE 2008-10-21	First issue

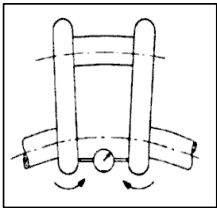
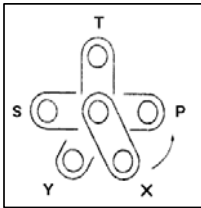
OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE				Project	YANGFAN2003	Owner	TB MARINE
SPECIFICATION OF ENGINE & ACCESSORIES				Eng. Type	5H21/32	Class	ABS
				Eng. No.	BA2768	Test Date	2008.09.28
				Eng. MCR	960kW	Evaluated by	H.Y.Park
				Gen. MCR	900kW	Operated by	J.S.Lee
Description							
Engine	Eng.No.	BA2768-1	BA2768-2		BA2768-3		
	Type	5H21/32					
	Power × rpm	960 kW x 900 rpm					
	Firing Order	1 - 2 - 4 - 5 - 3					
Generator	Model	HFC7 506-84K					
	Output & Volt	1125kVA 900 kW × 450 V					
	Current & Hz	1443.4A 60 Hz					
	Pole & PF	8 P 3 PHA PF 0.8					
	Ser.No.	20073405RAL57401	20073405RAL57402		20073405RAL57403		
Turbocharger	Type	TPS48-F33					
	Max. rpm & Temp.	57960rpm 620 °C					
	Maker	ABB					
	Ser.No.	HT492967	HT492968		HT492969		
Governor	Type	UG-25+					
	Maker	WOODWARD					
	Ser.No.	15921748	15921749		15921755		
Air Cooler	Cooling Surface	51.8m²					
	Maker	DONGHWA ENTEC					
	Ser.No.	DHJ7B270-A	DHJ7B270-B		DHJ7B270-C		
Lub.Oil Cooler	Cooling Surface	12.25m²					
	Maker	KPHE					
	Ser.No.	KPHE-2081806	KPHE-2081807		KPHE-2081808		
USED OIL AT SHOP TEST							
Description		Fuel Oil			Lub.Oil		
Kind of Oil		Bunker - A			Gadinia 40		
Specific Gravity (15/4℃)		0.9112			0.8934		
Flash Point (℃)		85			-		
Viscosity	50℃/cSt	6.31			-		
	40℃/cSt	-			128.8		
Carbon Residue (wt%)		1			-		
Ash (wt%)		0.01			-		
Water & Sediment (vol%)		0.05			-		
Sulfur (wt%)		0.273			-		
Net.Cal.Value (kcal/kg)		10009			-		

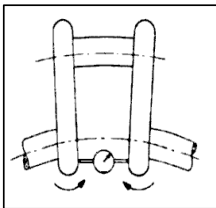
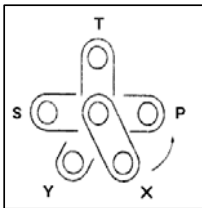
OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE																Project				YANGFAN2003				Owner				TB MARINE			
MEASURING RECORD(NO.1 D/G)																Eng. Type				5H21/32				Class				ABS			
																Eng. No.				BA2768 -1				Test Date				2008.09.28			
																Eng. MCR				960kW				Evaluated by				H.Y.Park			
																Gen. MCR				900kW				Operated by				J.S.Lee			
Time		hh:mm		09:10 ~ 09:40				09:40 ~ 10:10				10:10 ~ 10:40				10:40 ~ 11:40								11:40 ~ 12:20							
Ambient Press. / Temp.		mbar/℃		1022.0		21.5		1022.0		21.5		1022.0		22.3		1022.0		23.2		1022.0		23.5		1021.0		23.9					
Load Point		%		25%				50%				75%				100%								110%							
Engine Speed		rpm		900				900				900				900								900							
Generator Load		kW		223.7				458.4				690.9				920.1								1010.3							
Generator Efficiency		%		93.22				95.50				95.96				95.84								95.67							
Engine Load		kW		240.0				480.0				720.0				960.0								1056.0							
Fuel oil consumption		kg/h		-				-				-				189.600								-							
specific consumption		g/kW.h		-				-				-				197.500								-							
at ISO conditions		g/kW.h		-				-				-				193.006								-							
Governor Indicator Position		%		1.6				2.9				4.1				5.2				5.2				6.0							
Turbocharger Speed		rpm		26,740				37,780				46,480				53,140				53,170				55,440							
Lub. Oil Press. Inlet Filter		kg/cm²		4.90				5.30				5.20				5.20				5.20				5.10							
Lub. Oil Press. Inlet Engine		kg/cm²		4.70				5.20				5.00				4.90				4.90				4.90							
Lub. Oil Temp. Inlet engine		℃		65.0				66.0				66.0				67.0				67.0				67.0							
H.T. Water Press. Inlet Engine		kg/cm²		4.00				4.10				3.90				3.80				3.80				3.70							
H.T. Water Temp. Inlet/Outlet Engine		℃		78.0		80.0		78.0		79.0		78.0		80.0		77.0		80.0		77.0		80.0		77.0		80.0					
L.T. Water Press. Inlet Air Cooler		kg/cm²		2.30				2.70				2.50				2.40				2.40				2.30							
L.T. Water Temp. Inlet/Outlet Engine		℃		35.0		35.0		36.0		37.0		36.0		39.0		35.0		41.0		35.0		41.0		35.0		42.0					
Lub. Oil Press. Inlet Turbocharger		kg/cm²		4.00				3.80				3.50				3.30				3.30				3.30							
Fuel Oil Press. Inlet Engine		kg/cm²		6.10				5.90				5.70				5.60				5.60				5.50							
Fuel Oil Temp. Inlet Engine		℃		25				26				26				27				28				28							
Charge Air Press. After A/C		kg/cm²		0.49				1.10				1.89				2.68				2.68				2.98							
Charge Air Temp. After A/C		℃		37.0				39.0				40.0				41.0				41.0				42.0							
Exh. Gas Temp. T/C Outlet		℃		340				335				325				320				320				320							
Exh. Gas Temp. T/C Inlet				377		387		414		426		447		461		485		490		489		494		510		519					
Exh.gas Temp	Pump Index	Firing Press	Gen. Temp	Cyl.No	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃			
Cylinder Unit					No.1	325	9.0	85	-	340	13.0	123	-	360	17.5	159	-	395	22.5	187	-	395	22.5	187	-	410	25.0	198			
					No.2	290	9.0	83	-	320	13.0	122	-	340	17.5	157	-	395	23.0	185	-	395	22.5	185	-	410	25.0	197	-		
					No.3	320	9.0	84	-	340	13.0	122	-	350	17.5	158	-	375	22.5	187	-	375	22.5	187	-	390	25.0	198	-		
					No.4	320	9.0	84	-	340	13.0	122	-	360	17.5	158	-	395	22.5	186	-	395	22.5	186	-	410	24.5	197	-		
					No.5	320	9.0	83	-	350	13.0	122	-	375	17.5	158	-	410	22.5	185	-	410	22.5	185	-	430	24.5	197	-		
					No.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
					No.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
					No.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
					No.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
					mean	315.0	9.0	83.8	--	338.0	13.0	122.2	--	357.0	17.5	158.0	--	394.0	22.6	186.0	--	394.0	22.5	186.0	--	410.0	24.8	197.4	--		
Gen. Brg. Temp		℃		32				34				35				37				38				40							
★Safety Device Test																															
1. Overspeed Stop														1017/1035 rpm																	
2. Lub. Oil Low Pressure Stop														3.10 bar																	
3. H.T-Water High Temperature Stop														93.4 ℃																	
★Overhaul Inspection																															
5 Cyl.														2 Main Brg.																	

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE																Project		YANGFAN2003		Owner		TB MARINE								
MEASURING RECORD(NO.2 D/G)																Eng. Type		5H21/32		Class		ABS								
																Eng. No.		BA2768 -2		Test Date		2008.09.28								
																Eng. MCR		960kW		Evaluated by		H.Y.Park								
																Gen. MCR		900kW		Operated by		J.S.Lee								
Time		hh:mm		09:10 ~ 09:40		09:40 ~ 10:10		10:10 ~ 10:40		10:40 ~ 11:40						11:40 ~ 12:20														
Ambient Press. / Temp.		mbar/℃		1022.0 21.5		1022.0 21.5		1022.0 22.3		1022.0 23.2		1022.0 23.5		1021.0 23.9																
Load Point		%		25%		50%		75%		100%						110%														
Engine Speed		rpm		900		900		900		900						900														
Generator Load		kW		223.7		458.4		690.9		920.1						1010.3														
Generator Efficiency		%		93.22		95.50		95.96		95.84						95.67														
Engine Load		kW		240.0		480.0		720.0		960.0						1056.0														
Fuel oil consumption		kg/h		-		-		-		189.000						-														
specific consumption		g/kW.h		-		-		-		196.875						-														
at ISO conditions		g/kW.h		-		-		-		192.395						-														
Governor Indicator Position		%		1.7		3.8		4.7		5.8		5.8		6.2																
Turbocharger Speed		rpm		26,190		37,420		46,030		52,840		52,880		55,330																
Lub. Oil Press. Inlet Filter		kg/cm ²		5.30		5.20		5.10		5.10		5.10		5.00																
Lub. Oil Press. Inlet Engine		kg/cm ²		5.10		5.00		4.90		4.80		4.80		4.80																
Lub. Oil Temp. Inlet engine		℃		65.0		66.0		66.0		66.0		66.0		67.0																
H.T. Water Press. Inlet Engine		kg/cm ²		4.00		4.30		4.10		4.10		4.10		4.00																
H.T. Water Temp. Inlet/Outlet Engine		℃		78.0 79.0		78.0 79.0		78.0 79.0		77.0 79.0		78.0 79.0		77.0 79.0																
L.T. Water Press. Inlet Air Cooler		kg/cm ²		2.30		2.60		2.50		2.40		2.40		2.40																
L.T. Water Temp. Inlet/Outlet Engine		℃		35.0 36.0		36.0 39.0		35.0 40.0		35.0 42.0		35.0 42.0		35.0 43.0																
Lub. Oil Press. Inlet Turbocharger		kg/cm ²		3.70		3.50		3.30		3.10		3.10		3.00																
Fuel Oil Press. Inlet Engine		kg/cm ²		5.40		5.20		5.00		4.80		4.80		4.80																
Fuel Oil Temp. Inlet Engine		℃		25		26		28		30		31		32																
Charge Air Press. After A/C		kg/cm ²		0.52		1.12		1.91		2.69		2.69		2.98																
Charge Air Temp. After A/C		℃		37.0		39.0		40.0		41.0		41.0		42.0																
Exh. Gas Temp. T/C Outlet		℃		345		345		330		325		325		320																
Exh. Gas Temp. T/C Inlet				399 383		435 424		456 451		490 489		491 492		512 513																
Exh.gas Temp	Pump Index	Firing Press	Gen. Temp	Cyl.No	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃						
Cylinder Unit					No.1	325	9.0	84	-	350	13.0	123	-	370	17.5	158	-	400	22.5	187	-	400	22.5	187	-	420	24.5	198	-	
					No.2	315	9.0	84	-	345	13.0	123	-	360	17.5	159	-	380	22.5	187	-	380	22.5	187	-	400	24.5	198	-	
					No.3	320	9.0	83	-	335	13.0	122	-	350	17.5	157	-	380	22.5	185	-	380	22.5	185	-	400	24.5	197	-	
					No.4	295	9.0	82	-	330	13.0	121	-	350	17.5	156	-	380	22.5	185	-	380	22.5	185	-	400	24.5	197	-	
					No.5	345	9.0	84	-	360	13.0	122	-	380	17.5	158	-	405	22.5	186	-	405	22.5	186	-	425	24.5	197	-	
					No.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
					No.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
					No.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
					No.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
					mean	320.0	9.0	83.4	--	344.0	13.0	122.2	--	362.0	17.5	157.6	--	389.0	22.5	186.0	--	389.0	22.5	186.0	--	409.0	24.5	197.4	--	
Gen. Brg. Temp		℃		33		35		38		40		40		42																
★Safety Device Test																														
1. Overspeed Stop										1014/1034 rpm																				
2. Lub. Oil Low Pressure Stop										3.10 bar																				
3. H.T-Water High Temperature Stop										93.5 ℃																				
★Overhaul Inspection																														
Cyl.										Main Brg.																				

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE																Project				YANGFAN2003				Owner				TB MARINE			
MEASURING RECORD(NO.3 D/G)																Eng. Type				5H21/32				Class				ABS			
																Eng. No.				BA2768 -3				Test Date				2008.09.28			
																Eng. MCR				960kW				Evaluated by				H.Y.Park			
																Gen. MCR				900kW				Operated by				J.S.Lee			
Time		hh:mm		09:10 ~ 09:40				09:40 ~ 10:10				10:10 ~ 10:40				10:40 ~ 11:40								11:40 ~ 12:20							
Ambient Press. / Temp.		mbar/℃		1022.0		21.5		1022.0		21.5		1022.0		22.3		1022.0		23.2		1022.0		23.5		1021.0		23.9					
Load Point		%		25%				50%				75%				100%								110%							
Engine Speed		rpm		900				900				900				900								900							
Generator Load		kW		223.7				458.4				690.9				920.1								1010.3							
Generator Efficiency		%		93.22				95.50				95.96				95.84								95.67							
Engine Load		kW		240.0				480.0				720.0				960.0								1056.0							
Fuel oil consumption		kg/h		-				-				-				188.400								-							
specific consumption		g/kW.h		-				-				-				196.250								-							
at ISO conditions		g/kW.h		-				-				-				191.522								-							
Governor Indicator Position		%		2.3				3.3				4.3				5.6				5.6				6.1							
Turbocharger Speed		rpm		26,590				37,730				46,550				53,130				53,210				55,490							
Lub. Oil Press. Inlet Filter		kg/cm ²		5.10				5.10				5.00				4.90				4.90				4.80							
Lub. Oil Press. Inlet Engine		kg/cm ²		4.90				4.80				4.80				4.70				4.70				4.60							
Lub. Oil Temp. Inlet engine		℃		65.0				66.0				66.0				66.0				66.0				66.0							
H.T. Water Press. Inlet Engine		kg/cm ²		4.00				4.30				4.10				4.10				4.10				4.00							
H.T. Water Temp. Inlet/Outlet Engine		℃		78.0		79.0		78.0		79.0		78.0		79.0		77.0		79.0		77.0		79.0		77.0		80.0					
L.T. Water Press. Inlet Air Cooler		kg/cm ²		2.30				2.70				2.50				2.50				2.50				2.40							
L.T. Water Temp. Inlet/Outlet Engine		℃		36.0		37.0		37.0		38.0		37.0		39.0		37.0		41.0		36.0		41.0		37.0		42.0					
Lub. Oil Press. Inlet Turbocharger		kg/cm ²		3.80				3.50				3.30				3.10				3.10				3.00							
Fuel Oil Press. Inlet Engine		kg/cm ²		6.50				6.40				6.20				6.00				6.00				6.00							
Fuel Oil Temp. Inlet Engine		℃		24				25				27				28				29				30							
Charge Air Press. After A/C		kg/cm ²		0.47				1.09				1.86				2.64				2.64				2.93							
Charge Air Temp. After A/C		℃		37.0				39.0				39.0				40.0				41.0				41.0							
Exh. Gas Temp. T/C Outlet		℃		340				340				325				320				320				330							
Exh. Gas Temp. T/C Inlet				383		393		423		429		449		450		490		486		493		491		514		510					
Exh.gas Temp	Pump Index	Firing Press	Gen. Temp	Cyl.No	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃			
Cylinder Unit				No.1	330	9.0	84	-	345	13.0	122	-	370	18.0	159	-	400	22.5	188	-	400	22.5	188	-	420	24.5	199	-	-		
				No.2	325	9.0	84	-	350	13.0	123	-	375	18.0	158	-	400	22.5	187	-	400	22.5	187	-	420	24.5	198	-	-		
				No.3	315	9.0	83	-	325	13.0	121	-	355	18.0	157	-	380	22.5	186	-	380	22.5	186	-	400	24.5	197	-	-		
				No.4	295	9.0	83	-	330	13.0	122	-	360	17.5	157	-	390	22.5	186	-	390	22.5	186	-	410	24.5	197	-	-		
				No.5	335	9.0	84	-	350	13.0	123	-	365	17.5	158	-	400	22.5	186	-	400	22.5	186	-	420	24.5	198	-	-		
				No.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
				No.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
				No.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
				No.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
				mean	320.0	9.0	83.6	--	340.0	13.0	122.2	--	365.0	17.8	157.8	--	394.0	22.5	186.6	--	394.0	22.5	186.6	--	414.0	24.5	197.8	--	-		
Gen. Brg. Temp		℃		31				34				36				39				40				40							
★Safety Device Test																															
1. Overspeed Stop														1017/1034 rpm																	
2. Lub. Oil Low Pressure Stop														3.10 bar																	
3. H.T-Water High Temperature Stop														93.6 ℃																	
★Overhaul Inspection																															
Cyl.														Main Brg.																	

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE					Project	YANGFAN2003	Owner	TB MARINE			
SETTING TABLE (No. 1 D/G)					Eng. Type	5H21/32	Class	ABS			
					Eng. No.	BA2768 -1	Test Date	2008.09.28			
					Eng. MCR	960kW	Evaluated by	H.Y.Park			
					Gen. MCR	900kW	Operated by	J.S.Lee			
Atomizer	Mark No. : H21FV1 Injection Hole : 10 Holes X ϕ 0.32 mm X 148°										
Clearance of Valves	Inlet Valve : 0.5 mm (Cold Condition) Exhaust Valve : 0.5 mm (Cold Condition)										
Adjustment of Fuel Injection Pump	[UNIT : mm]										
	Cylinder No.	1	2	3	4	5	6	7	8	9	
	Thrust Plate	13.70	13.60	13.30	13.30	13.50	-	-	-	-	
	Shim	0.00	0.00	0.00	0.00	0.00	-	-	-	-	
	Index by Maximum Supply of F.O	25.0	25.0	25.0	24.5	24.5	-	-	-	-	
	Index with Handle Stop	0.0	0.0	0.0	0.0	0.0	-	-	-	-	
Crankshaft Deflection	Coupling Type Between Engine and Generator : [UNIT : 1/100mm]										
	Cylinder No.	1	2	3	4	5	6	7	8	9	
	Cold Condition	Near Bottom X	0	0	0	0	0	-	-	-	-
		Camshaft Side P	0	+1.0	+1.0	-2.0	-6.0	-	-	-	-
		Top T	0	+2.0	+2.0	-3.0	-17.0	-	-	-	-
		Exhaust Side S	0	+1.0	+1.0	-2.0	-6.0	-	-	-	-
		Near Bottom Y	0	0	0	0	0	-	-	-	-
	Hot Condition	Near Bottom X	0	0	0	0	0	-	-	-	-
		Camshaft Side P	0	+1.0	+1.0	-2.0	-6.0	-	-	-	-
		Top T	0	+3.0	+1.0	-3.0	-12.0	-	-	-	-
		Exhaust Side S	0	+1.0	+1.0	-2.0	-6.0	-	-	-	-
		Near Bottom Y	0	0	0	0	0	-	-	-	-
	Reference Temperature Data for Hot Condition					Room Temperature : 24 °C					
						Lub. Oil Temperature in Oil Sump : 69 °C					
											
	"Closing" of The Crankthrow is Considered Negative.					Viewed from the front end Start in Position X. Turn Counter Clockwise.					

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE						Project	YANGFAN20 03		Owner	TB MARINE	
SETTING TABLE (No. 2 D/G)						Eng. Type	5H21/32		Class	ABS	
						Eng. No.	BA2768 -2		Test Date	2008.09.28	
						Eng. MCR	960kW		Evaluated by	H.Y.Park	
						Gen. MCR	900kW		Operated by	J.S.Lee	
Atomizer	Mark No. : H21FV1 Injection Hole : 10 Holes X ϕ 0.32 mm X 148°										
Clearance of Valves	Inlet Valve : 0.5 mm (Cold Condition) Exhaust Valve : 0.5 mm (Cold Condition)										
Adjustment of Fuel Injection Pump	[UNIT : mm]										
	Cylinder No.	1	2	3	4	5	6	7	8	9	
	Thrust Plate	13.20	13.40	13.20	13.30	13.10	-	-	-	-	
	Shim	0.00	0.00	0.00	0.00	0.00	-	-	-	-	
	Index by Maximum Supply of F.O	24.5	24.5	24.5	24.5	24.5	-	-	-	-	
	Index with Handle Stop	0.0	0.0	0.0	0.0	0.0	-	-	-	-	
Crankshaft Deflection	Coupling Type Between Engine and Generator : [UNIT : 1/100mm]										
	Cylinder No.	1	2	3	4	5	6	7	8	9	
	Cold Condition	Near Bottom X	0	0	0	0	0	-	-	-	-
		Camshaft Side P	-1.0	0	+1.0	-2.0	-7.0	-	-	-	-
		Top T	-1.0	+1.0	+1.0	-3.0	-17.0	-	-	-	-
		Exhaust Side S	-1.0	0	+1.0	-2.0	-6.0	-	-	-	-
		Near Bottom Y	0	0	0	0	0	-	-	-	-
	Hot Condition	Near Bottom X	0	0	0	0	0	-	-	-	-
		Camshaft Side P	-1.0	+1.0	0	-2.0	-6.0	-	-	-	-
		Top T	-2.0	+2.0	0	-4.0	-12.0	-	-	-	-
		Exhaust Side S	-1.0	+1.0	0	-2.0	-6.0	-	-	-	-
		Near Bottom Y	0	0	0	0	0	-	-	-	-
	Reference Temperature Data for Hot Condition					Room Temperature : 24 °C					
						Lub. Oil Temperature in Oil Sump : 69 °C					
	 "Closing" of The Crankthrow is Considered Negative.					 Viewed from the front end Start in Position X. Turn Counter Clockwise.					

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE						Project	YANGFAN2003	Owner	TB MARINE		
SETTING TABLE (No. 3 D/G)						Eng. Type	5H21/32	Class	ABS		
						Eng. No.	BA2768 -3	Test Date	2008.09.28		
						Eng. MCR	960kW	Evaluated by	H.Y.Park		
						Gen. MCR	900kW	Operated by	J.S.Lee		
Atomizer	Mark No. : H21FV1										
	Injection Hole : 10 Holes X ϕ 0.32 mm X 148°										
Clearance of Valves	Inlet Valve : 0.5 mm (Cold Condition)										
	Exhaust Valve : 0.5 mm (Cold Condition)										
Adjustment of Fuel Injection Pump	[UNIT : mm]										
	Cylinder No.	1	2	3	4	5	6	7	8	9	
	Thrust Plate	13.20	13.30	13.50	13.20	13.50	-	-	-	-	
	Shim	0.00	0.00	0.00	0.00	0.00	-	-	-	-	
	Index by Maximum Supply of F.O	24.5	24.5	24.5	24.5	24.5	-	-	-	-	
	Index with Handle Stop	0.0	0.0	0.0	0.0	0.0	-	-	-	-	
Crankshaft Deflection	Coupling Type Between Engine and Generator : [UNIT : 1/100mm]										
	Cylinder No.	1	2	3	4	5	6	7	8	9	
	Cold Condition	Near Bottom X	0	0	0	0	0	-	-	-	-
		Camshaft Side P	-1.0	+1.0	+1.0	-1.0	-6.0	-	-	-	-
		Top T	-2.0	+1.0	+1.0	-2.0	-11.0	-	-	-	-
		Exhaust Side S	-1.0	+1.0	+1.0	-1.0	-5.0	-	-	-	-
		Near Bottom Y	0	0	0	0	0	-	-	-	-
	Hot Condition	Near Bottom X	0	0	0	0	0	-	-	-	-
		Camshaft Side P	-1.0	+1.0	0	-1.0	-6.0	-	-	-	-
		Top T	-2.0	+2.0	+1.0	-2.0	-12.0	-	-	-	-
		Exhaust Side S	-1.0	+1.0	0	-1.0	-6.0	-	-	-	-
		Near Bottom Y	0	0	0	0	0	-	-	-	-
	Reference Temperature Data for Hot Condition					Room Temperature : 24 °C					
						Lub. Oil Temperature in Oil Sump : 69 °C					
											
	"Closing" of The Crankthrow is Considered Negative.					Viewed from the front end Start in Position X. Turn Counter Clockwise.					

GOVERNOR TEST & GENERATOR PARALLEL RUNNING TEST	Project	YANGFAN2003	Owner	TB MARINE
	Eng. Type	5H21/32	Class	ABS
	Eng. No.	BA2768	Test Date	2008.09.28
	Eng. MCR	960kW	Evaluated by	H.Y.Park
	Gen. MCR	900kW	Operated by	J.S.Lee

1.GOVERNOR TEST

No. 1 D/G

LOAD %		SPEED VARIATION						GOV. SETTING	GOV. TYPE	UG-25+
FROM	TO	BEF.Hz	MOM.Hz	DIFF. %	PER.Hz	DIFF. %	TIME		SERIAL NO.	15921748
100	0	60.0	63.0	5.00%	62.2	3.67%	1.4sec		SPEED DROOP	5
0	38	62.2	61.5	1.13%	61.5	1.13%	0.8sec		STABILITY	5
38	66	61.5	60.5	1.63%	61.0	0.81%	2.0sec		-	-
66	100	61.0	59.5	2.46%	60.0	1.64%	2.4sec		-	-

No. 2 D/G

LOAD %		SPEED VARIATION						GOV. SETTING	GOV. TYPE	UG-25+
FROM	TO	BEF.Hz	MOM.Hz	DIFF. %	PER.Hz	DIFF. %	TIME		SERIAL NO.	15921749
100	0	60.0	62.5	4.17%	62.5	4.17%	1.0sec		SPEED DROOP	5
0	38	62.5	61.5	1.60%	61.5	1.60%	0.6sec		STABILITY	5
38	66	61.5	61.0	0.81%	60.5	1.63%	0.8sec		-	-
66	100	60.5	59.5	1.65%	60.0	0.83%	2.2sec		-	-

No. 3 D/G

LOAD %		SPEED VARIATION						GOV. SETTING	GOV. TYPE	UG-25+
FROM	TO	BEF.Hz	MOM.Hz	DIFF. %	PER.Hz	DIFF. %	TIME		SERIAL NO.	15921755
100	0	60.0	63.0	5.00%	62.2	3.67%	1.0sec		SPEED DROOP	5
0	38	62.2	62.0	0.32%	61.5	1.13%	0.6sec		STABILITY	5
38	66	61.5	61.0	0.81%	61.0	0.81%	2.0sec		-	-
66	100	61.0	60.0	1.64%	60.0	1.64%	2.6sec		-	-

2. PARALLEL RUNNING TEST

D/G NO.	LOAD	%	75	100	80	60	40	20	40	60	80	100	75
	VOLTAGE	V	448	448	448	448	448	448	448	448	448	448	448
	FREQUENCY	Hz	60	59	60	60	61	61	61	60	60	59	60
NO.1	OUTPUT	kW	665	902	720	540	367	173	372	547	720	905	665
NO.2	OUTPUT	kW	679	895	720	552	370	182	377	552	715	895	667
NO.3	OUTPUT	kW	674	912	727	545	358	175	370	538	710	907	670

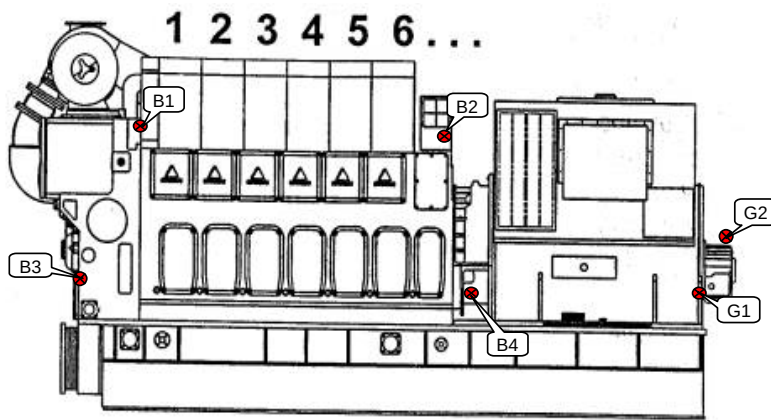
OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE		Project	YANGFAN2003	Owner	TB MARINE
MECHANICAL VIBRATION MEASUREMENT		Eng. Type	5H21/32	Class	ABS
		Eng. No.	BA2768	Test Date	2008.09.28
		Eng. MCR	960kW	Measured by	H.B.Jeon/QM
		Gen. MCR	900kW		

Measurement Equipment

Manufacture	Type	Mechanical connection	Measured value	Recorded value	Measurement Equipment
RION	VM - 61	magnetic	velocity	velocity	
RION	VM - 82	magnetic	velocity	velocity	0

Vibration Measurement Location and Limit Value

Measuring Points (ISO 8528-9)		Direction	Limit Value	Remarks
B1	Front End Top Edge	X, Y, Z	≤ 28 mm/s (Vrms)	ISO 10816-6
B2	Back End Top Edge	X, Y, Z		
B3	Front End of Base Frame	X, Y, Z		
B4	Front End of Generator Base Frame	X, Y, Z		
G1	Rear End of Generator Base Frame	X, Y, Z	≤ 20 mm/s (Vrms)	ISO 8528-9
G2	Generator Bearing	X, Y, Z		

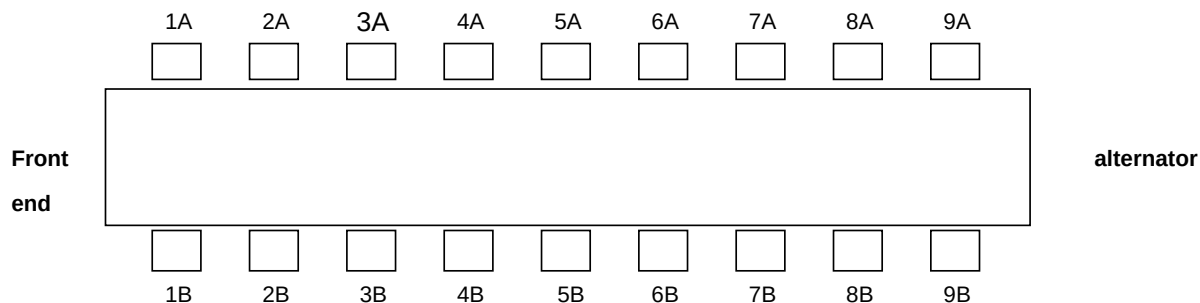
Measurement points


UNIT : V rms (mm/s)

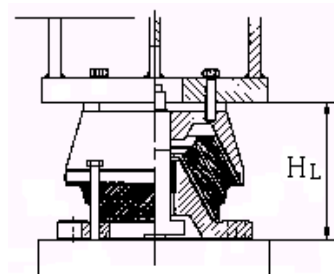
D/G	Item	Measuring Point	axial (X)	transverse (Y)	vertical (Z)	Remarks
NO.1 D/G		B1	4.9	8.8	9.9	▶ Coupling : Disc coupled [with Generator] ▶ Erection : Rubber Mount Type YE7000SH45 ▶ Load % : 100% ▶ Running hours : 1 Hr
		B2	4.0	8.4	9.7	
		B3	5.1	12.0	13.0	
		B4	4.5	8.3	14.0	
		G1	4.7	11.6	18.0	
		G2	4.9	11.2	17.0	
NO.2 D/G		B1	4.5	8.1	11.0	
		B2	4.5	8.7	9.0	
		B3	4.7	11.2	14.0	
		B4	4.6	7.8	14.0	
		G1	4.5	11.1	16.0	
		G2	4.8	10.5	15.0	
NO.3 D/G		B1	4.6	7.8	9.7	
		B2	3.9	8.5	9.4	
		B3	4.2	8.3	14.0	
		B4	4.2	8.3	14.0	
		G1	3.9	10.1	17.0	
		G2	5.7	9.1	16.0	
NO.4 D/G		B1	-	-	-	
		B2	-	-	-	
		B3	-	-	-	
		B4	-	-	-	
		G1	-	-	-	
		G2	-	-	-	

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE HEIGHT OF RESILIENT SUPPORTS IN LOADED CONDITION	Project	YANGFAN20 03	Owner	TB MARINE
	Eng. Type	5H21/32	Class	ABS
	Eng. No.	BA2768	Test Date	2008.09.28
	Eng. MCR	960kW	Evaluated by	H.Y.Park
	Gen. MCR	900kW	Operated by	J.S.Lee

Mount Type : YE7000SH45


 H_L = Height of resilient support in loaded condition

Note ! This flexible elements must be loaded for
at least 48 hours, before measurements are taken



Resilient support NO.		1A	2A	3A	4A	5A	6A	7A	8A	9A	Remarks
		1B	2B	3B	4B	5B	6B	7B	8B	9B	
H_L (mm)	No. 1 D/G	169.0	168.5	168.5	169.0	-	-	-	-	-	
		169.0	168.5	168.5	169.0	-	-	-	-	-	
	No. 2 D/G	169.0	169.0	169.0	169.0	-	-	-	-	-	
		169.0	168.0	169.0	168.5	-	-	-	-	-	
	No. 3 D/G	169.0	168.5	169.0	169.0	-	-	-	-	-	
		169.0	168.0	169.0	169.0	-	-	-	-	-	
	No. 4 D/G	-	-	-	-	-	-	-	-	-	
		-	-	-	-	-	-	-	-	-	

REMARK.:

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE			Project	YANGFAN20 03	Owner	TB MARINE
CALCULATION SHEET OF F.O.			Eng. Type	5H21/32	Class	ABS
			Eng. No.	BA2768	Test Date	2008.09.28
			Eng. MCR	960kW	Evaluated by	H.Y.Park
			Gen. MCR	900kW	Operated by	J.S.Lee

Description									
Engine No.			No.1D/G		No.2D/G		No.3D/G		No.4D/G
Output	Load	%	100%		100%		100%		
	Engine Speed	rpm	900		900		900		
	Generator Output	kW	920.1		920.1		920.1		
	Generator Efficiency	%	95.84		95.84		95.84		
	Engine Output	kW	960.0		960.0		960.0		
		BHP	1305.2		1305.2		1305.2		
Actual Measurement	Time	min/sec	30min	0.00sec	20min	0.00sec	30min	0.00sec	
	F.O. Consumption	kg	94.800		63.000		94.200		
		kg/h	189.600		189.000		188.400		
	SFOC _{amb}	g/kW.h	197.500		196.875		196.250		
		g/BHP.h	145.261		144.802		144.342		
ISO Convers. Factor	Ambient Air Temp. (Ta-25)×0.05	℃	23.2		23.2		23.2		
		%	-0.09		-0.09		-0.09		
	Ambient Air Press. (Pa-1000)×0.007	mbar	1022.0		1022.0		1022.0		
		%	0.1540		0.1540		0.1540		
	C.W. to Air Cooler (T _{cw} -25)×0.07	℃	35		35		37		
		%	0.7		0.7		0.84		
	Low Calorific Value (LCV-10200)/102	kcal/kg	10009		10009		10009		
		%	-1.87255		-1.87255		-1.87255		
	dSFOC [100+(Ta-25)×0.05 -(Pa-1000)×0.007 +(T _{cw} -25)×0.07 -(LCV-10200)/102]/100		1.0233		1.0233		1.0247		
S.F.O.C(ISO)		g/kW.h	193.006		192.395		191.522		
= SFOC _{amb} / dSFOC		g/BHP.h	141.956		141.507		140.865		

All values based on ISO 3046/1 conditions

Ambient air temperature : 25 ℃

Ambient air pressure : 1000 mbar

Cooling water for air cooler : 25 ℃

Marine diesel oil(MDO). Lower calorific value : 42,700 kJ/kg (10,200 kcal/kg)

For other reference conditions, the SFOC is to be corrected by :

Ambient air temperature rise 10℃ 0.5 %

Ambient air pressure rise 10mbar -0.07 %

Cooling water for air cooler rise 10℃ 0.7 %

Lower calorific value rise 1% -1.0 %

Working Drawings of Diesel Generator Engine

Hull No. : YANGFAN2003/2004/2005/2006
/2007/2008

Engine Type : 3 x 5H21/32 x 900rpm



NO.	DESCRIPTION	DRAWING NO.	REMARKS
1	TECHNICAL ENGINE SPECIFICATION	B94-025987-1.1	
2	HEAT CALCULATION DIAGRAM	B94-017050-6.0	
3	LUB. OIL IN BASE FRAME	B94-000419-0.4	
4	L.O CHART FOR HIMSEN ENGINE	B94-015292-3.1	
5	HOLDING DOWN BOLT ARRANGEMENT	B90-027333-7.4	
6	INSTRUCTION FOR RESILIENT MOUNT.	B93-027341-9.1	
7	GENERAL ARRANGEMENT	B90-029610-1.1	
8	OVERHAUL DIMENSION OF MAIN COMPONENTS	B90-023817-1.1	
9	BASIC SYMBOLS FOR PIPING DIAGRAM	B12-103680-4.3	
10	FUEL OIL SYSTEM	B92-029611-3.0	
11	LUBRICATING OIL SYSTEM	B92-029612-5.0	
12	COOLING WATER SYSTEM	B92-029613-7.0	
13	COMPRESSED AIR SYSTEM	B92-029614-9.0	
14	COMBUSTION AIR SYSTEM	B92-029615-0.0	
15	LIST FOR FLEXIBLE HOSE CONNECTION	B94-015157-6.4	
16	COUNTER FLANGES, GASKETS BOLTS & NUTS	B94-029619-8.0	
17	PRESSURE REGULATING VALVE FOR M.D.O.OU	B92-029616-2.1	
18	PRESSURE REGULATING VALVE FOR M.D.O.IN	B92-029617-4.1	
19	PRESSURE REGULATING VALVE FOR HFO-9BA	B93-029618-6.0	
20	PRE LUBRICATING OIL PUMP	B12-154541-7.0	
21	WATER SHUT-OFF VALVE 80A	B92-027626-0.0	
22	EXPANSION JOINT FOR T/C OUTLET	B93-011552-0.3	
23	TURBOCHARGER CLEANING HOSE	B12-116265-8.4	
24	ELECTRIC PRE-HEATER ASS'Y	B91-009930-0.3	
25	SENSOR LIST&ELEC.CONN.DIAGRAM	B94-018701-6.1	
26	LOCAL CONTROL PANEL W/PUMP/J.W.PRE. ST	B94-029865-7.1	
27	LIST OF SPARE PARTS	B94-031601-1.2	
28	LIST OF TOOL PARTS	B94-030434-0.2	
29	GENERATOR	B94-026013-9.2	

PLAN HISTORY					ENGINE TYPE	HYUNDAI-HIMSEN 3 x 5H21/32 x 900 rpm
△1 △1 △1					MESSRS	Yangfan Group Co.,Ltd
					RULE	ABS
					PROJECT	Yangfan2003~2008
					ENG. NO.	BA2768-2773
TITLE : TECHNICAL ENGINE SPECIFICATION for DIESEL GENERATOR ENGINE						
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	R
				*		5
				*		4
				*		3
				*		2
20090827	KGH	KJC	KBY	*	Changed hull no.	1
20070921	KJC	KJC	KKS	*		0
Similar drawing No.:					Replacement for Ident. No.:	
Licenser Ident. No.:				Type:		
Info. No.:				5H21/32		
Page. No.:				Description:		Ident.no.:
01 OF 10				Technical Engine Specification		B94-025987-1

INDEX OF CONTENTS

<u>CONTENTS</u>	<u>PAGE</u>
1. GENERAL -----	2
2. PRINCIPAL PARTICULARS -----	3
3. DESCRIPTION OF MAJOR COMPONENTS -----	4
4. ENGINE AUXILIARY EQUIPMENTS -----	6
5. SPARE PARTS AND TOOLS -----	8
6. WORKSHOP TEST -----	8
7. ENGINE CHARACTERISTICS -----	9

1. GENERAL

1.1 RULES AND REGULATIONS

The diesel engine shall be complied with the requirements of the following rules and regulations of the latest issue.

- . Classification Society : ABS
- . Application Standards : KS, JIS or DIN
- . Miscellaneous : Engine manufacturer's standards

1.2 INSTALLATIONS

The engine is directly coupled with disc plate to the alternator and placed together on the common base frame fabricated in steel plate.

The genset is mounted with resilient vibration-free isolators onto the hull foundation.

1.3 PIPE CONNECTION FLANGES

Pipe connection flanges of the engine connected to the hull piping are provided in accordance with JIS standards if not mentioned otherwise.

All counterflanges are to be provided by engine manufacturer.

1.4 LANGUAGE

All name/instruction plates are written in English.

1.5 PAINTING

All parts of casting surfaces are coated with anti-corrosive primer and finally painted of the engine exterior surfaces in Munsell no. 7.5 BG 7/2.

1.6 FUEL OIL

The engine together with proper external feed system can be operated on heavy fuel oil of viscosity up to 700 cSt at 50°C, which corresponds to the grades of CIMAC H700 (CIMAC Recommendation No. 21, 2003).

The viscosity entering the engine should be kept within approx. 12 - 18 cSt.

1.7 LUBRICATING OIL

For the engine, a HD-lubricating oil (heavy duty) corresponding to at least type CD Commercial Class D according to the API service system has to be used.

The viscosity with SAE 40 (145 cSt at 40°C) is always to be used.

2. PRINCIPAL PARTICULARS

2.1 DIESEL ENGINE

Vertical in-line, 4-cycle, direct injection, single acting, trunk piston type with exhaust turbocharged and charge air cooled design

. Model	: 5H21/32
. No. of cylinder	: 5
. Cylinder bore x piston stroke	: 210 mm x 320 mm
. Out-put at MCR	: 960 kW at 900 rpm according to ISO 3046/1
. Brake-mean effective pressure	: 23.1 bar
. Mean piston speed	: 9.6 m/s
. Maximum combustion pressure	: ** bar
. Dry weight of genset (approx.)	: Refer to General Arr't Drawing
. No. of diesel engine	: 3 set(s)/ship
. Rotating direction (seen from flywheel)	: Clock-wise

**) Note

- . Please refer to the actual data on the shop test result for each project.
- . Allowable deviation of individual cylinders from average of total cylinders : ± 5 bar

2.2 ALTERNATOR

. Maker	: HHI-Electro Electric Systems
. Alternator model	: HFC7 506-84K
. Alternator capacity	: 900 kW / 60 Hz / 450 VAC

3. DESCRIPTION OF MAJOR COMPONENTS

3.1 CHARGE AIR COOLER

- . Tube with fin type, one stage, attached water mist catcher.

3.2 TURBOCHARGER

- . Pulse charging type, un-cooled casings, no water connections
- . Lubrication by engine system oil with SAE 40.

3.3 GOVERNOR

- . Microprocessor controlled hydraulic type, and speed adjustment, speed droop and load limit controls are standard feature.

3.4 TURNING FOR FLYWHEEL

- . Manual turning by ratchet with turning rod.

3.5 COMPRESSED AIR SYSTEM

- . Supply of compressed air of max. 30 bar is required from the starting air reservoir, and the compressed air is reduced through a pressure regulating valve for starting the engine by air motor starter.

3.6 COOLING WATER SYSTEM

- . The cooling water system consists of a low temperature system and a high temperature system.
- . Both cooling water pumps and thermostatic valves can be mounted on engine.

3.7 FUEL OIL SYSTEM

- . The fuel injection equipments comprise an injection pump, a connection block, an injection pipe and an injection valve, which are installed on each cylinder in line.

3.8 LUBE OIL SYSTEM

- . The engine driven main L.O pump, electric motor driven prelubricating pump, 15 micron safety filter, and pressure regulating valve are mounted on engine.

3.9 ENGINE CONTROL AND MONITORING SYSTEM

- . Each piping system has thermometers and pressure gauges for local reading, and all of pressure gauges are fitted on the gauge board.
- . The numbers and types of pressure/temperature sensors are chosen according to the requirements of the classification society.
- . The engine has shut-down functions as standard for lubricating oil pressure low, cooling water temperature high and for overspeed.

3.10 ENGINE SHUT-DOWN AND OVERSPEED STOP

- . The engine shut-down and overspeed trip can be done by an electro pneumatic on-off valve.

3.11 MATERIAL SPECIFICATION OF MAJOR COMPONENTS

- | | |
|------------------------------------|---|
| . Engine block | : Gray cast iron |
| . Front end block | : Gray cast iron |
| . Crankshaft | : Forged, hardened and tempered Cr-Mo steel |
| . Connecting rod | : Forged, hardened and tempered Cr-Mo steel |
| . Piston | : Maker standard |
| . Cylinder head | : Spherical graphite cast iron |
| . Cylinder liner | : Special alloy cast iron |
| . Exhaust and inlet valve spindles | : Heat treated Cr-Mn-Si alloy |
| . Fuel injection pump & valve | : Maker standard |
| . Turbocharger | : Maker standard |
| . Governor | : Maker standard |

4. ENGINE AUXILIARY EQUIPMENT

The following accessory components are equipped on the engine except (*) marked components which shall be delivered separately.

The quantities of components are provided as per each engine, unless otherwise mentioned.

4.1 FUEL OIL SYSTEM

- . Fuel injection equipment on each cylinder
- . Fuel leakage tank with level switch
- . Fuel oil safety filter, duplex manual (50 micron)
- (*) . Pressure control valves on external fuel piping (each 1 pc/ship)

4.2 LUBRICATING OIL SYSTEM

- . Engine driven lube oil pump
- . Plate type lube oil cooler
- . Lube oil thermostatic valve, wax type
- . Duplex lube oil filter (15 micron)
- . Pressure regulating valve
- . Electric motor driven prelubricating pump

4.3 COOLING WATER SYSTEM

- . Engine driven HT-cooling water pump
- . HT-cooling water thermostatic valve, wax type
- . Electric preheater
- (*) . Cooling water shut-off valve for cooling water inlet

4.4 AIR INTAKE AND COMPRESSED AIR SYSTEM

- . Intake mat filter on turbocharger as standard specification
- . Air motor starter for engine starting
- . Main starting / emergency starting valve
- . On-off valve for engine stop and over speed stop

4.5 COMBUSTION AIR AND EXHAUST SYSTEM

- . Charge air cooler with water mist catcher, one stage
- . Exhaust gas turbocharger, pulse charging
- . Water cleaning device for turbocharger compressor
- . Wet cleaning device for turbocharger turbine
- (*) . Expansion joint for turbocharger outlet

4.6 CONTROL AND MONITORING SYSTEM

- . Hydraulic speed governor
- . Local instruments
 - Direct reading thermometers on each piping
 - Direct reading pressure gauges collected together on the gauge board
 - Start/stop button with tachometer for engine/turbocharger rpm in starting box
- (*) . Local control panel with prelubricating oil pump and J.W.heater starter (1 set/ship)

4.7 MISCELLANEOUS

- . Resilient mounting with conical rubber elements
- (*) . Flexible hoses for external pipe connections

5. SPARE PARTS AND TOOLS

The spare parts and tools are provided in accordance with engine manufacturer's standards practice and the requirement or recommendation of each relevant classification society.

5.1 STANDARD SPARE PARTS ----- One(1) set per ship

5.2 STANDARD TOOLS ----- One(1) set per ship

6. WORKSHOP TEST

The engine shop trial is carried out in accordance with engine manufacturer's standard practice and the requirement of each relevant classification society.
The shop trial shall be done under the engine being coupled with alternator and use of marine diesel oil.

6.1 START-UP

6.2 LOAD TEST in % of engine output

- . 0.5 hour at 25% load
- . 0.5 hour at 50% load
- . 0.5 hour at 75% load
- . 1.0 hour at 100% load
- . 0.5 hour at 110% load

6.3 FUEL CONSUMPTION MEASUREMENT at MCR only

6.4 GOVERNOR TEST by 3-step load application

6.5 PARALLEL RUNNING TEST

6.6 SAFETY FUNCTION TEST for emergency trip

6.7 MECHANICAL VIBRATION MEASUREMENT at MCR only

6.8 OVERHAUL INSPECTION in one(1) cylinder per ship

6.9 NOx CERTIFICATION according to IMO NOx regulation

7. ENGINE CHARACTERISTICS

7.1 ENGINE PERFORMANCE

. Specific fuel oil consumption *)	: 194	g/kWh +5% at MCR
. Combustion air consumption	: 7,000	kg/h, tolerance +/- 5%
. Exhaust gas flow	: 7,200	kg/h, tolerance +/- 5%
. Allowable exhaust gas back pressure	: 0.03	bar, max.
. Engine noise level	: Max.110	dB(A) in IMO limit.
. NOx emission	: Max.11.5	g/kWh in IMO limit
. Load-up application	: 3	steps

*) The SFOC value is stated under condition of

- . ISO 3046/1 reference condition
- . Fuel oil based on MDO, Lower calorific value 42,700 kJ/kg at shop test
- . With engine driven pumps (L.O. pump and cooling water pump only)
- . If other engine driven pump(s) be fitted, the SFOC will be increased.

7.2 REFERENCE UTILITIES

. HT & LT cooling water volume on engine	: 302	liter
. Minimum water volume on expansion tank	: 100 + (*)	liter / 3 engine(s)
. Maximum air source for engine starting	: 30	bar compressed air
. Fuel oil supply pump (head)	: 0.34	m ³ /h x 4 bar/engine
. Fuel oil booster pump (head)	: 0.68	m ³ /h x ** bar/engine

(*) : Min. 10% of the HT & LT water volume of additional engine(s).

(**) : 8 bar at engine inlet (F1 connection)

Note : Cooling water pressure at engine inlet to be kept under 2.5 bar by shipbuilder.

7.3 LIST OF CAPACITY

. Overload capacity for 1 hour within 12 hour	: 110	%
. Minimum ambient air temp. for starting	: 5	°C
. Minimum preheating of jacket for starting	: 60	°C
. Minimum preheating of lube oil for starting	: 40	°C
. Maximum ambient temperature of E/R	: 45	°C
. Starting air consumption per start	: 0.9	N m ³
. Capacity of engine driven pumps		
. Lubricating oil pump	: 41	m ³ /h Gear
. HT-cooling water pump	: 35	m ³ /h Centrifugal

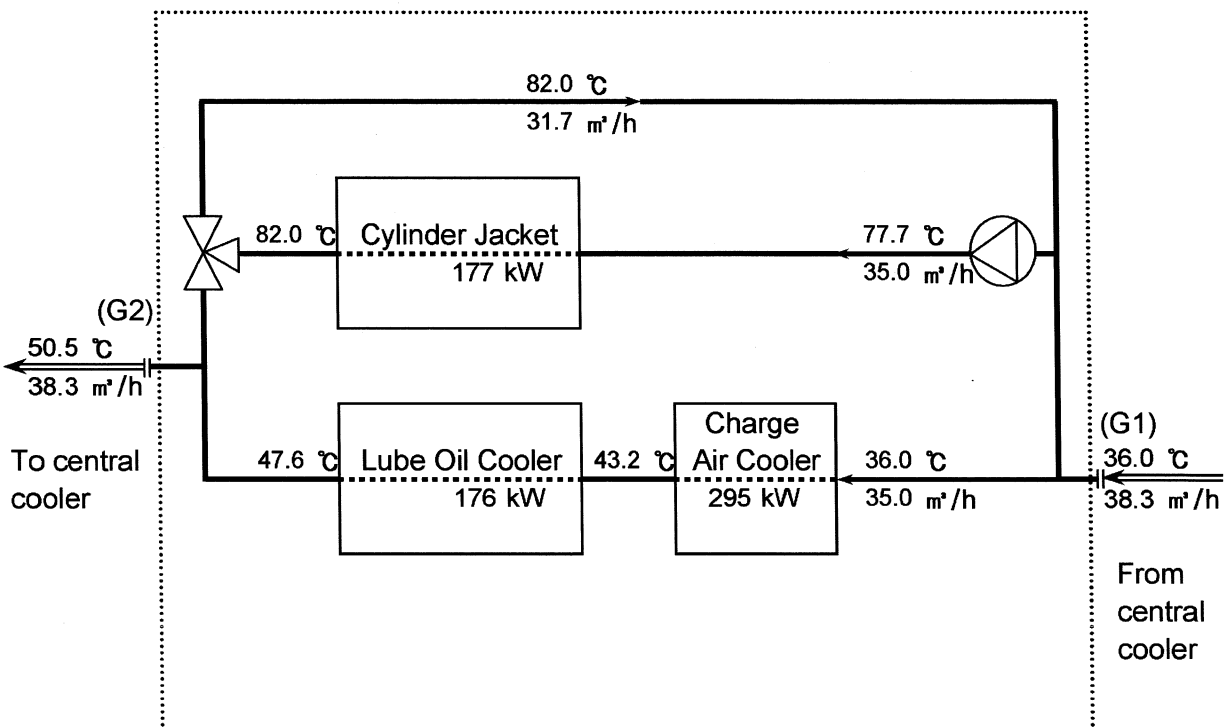
Heat Dissipation (Tropical condition, Tolerance 10%)

Cylinder jacket : 177 kW
Lubricating oil : 176 kW
LT-Charge air : 295 kW

HT-Water Pump : 35 m³/h

HT-Thermostatic Valve : 82 °C Set

Cooling Media : 36 °C / Max, External Fresh Water

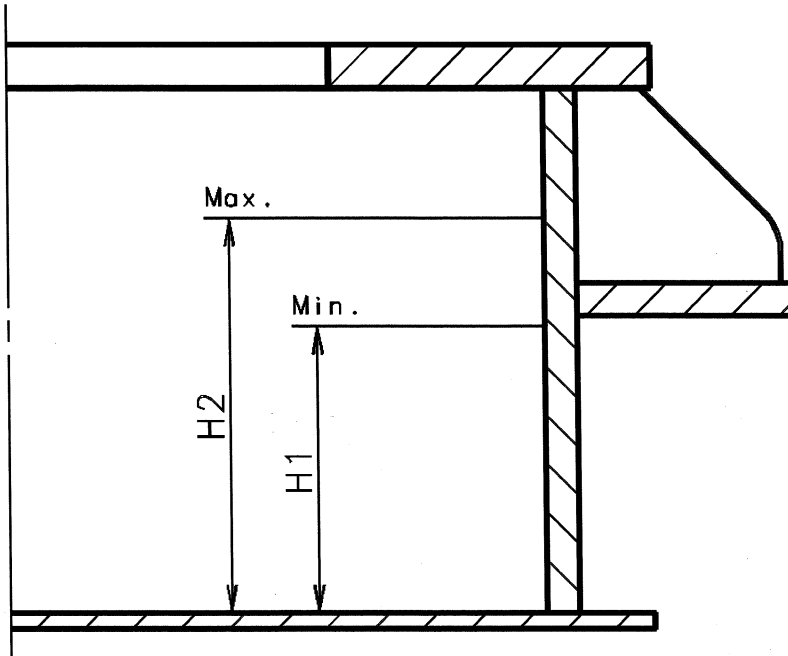


C.W. inlet temp : 36 °C , then C.W. outlet temp : 50.5 °C
C.W. flow rate : 38.3 m³/h

* At different C.W. inlet temp., the outlet temp. and flow will be changed accordingly.

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No.
				*	*	Replaced by Ident. No. :	5
				*	*		4
				*	*		3
				*	*		2
				*	*		1
2007.05.25	HJS	HJS	KKS	*	*		0
Similar Drawing No. :						Replacement of Ident. No. :	
Scale :	Size :	Type :				Page No. :	
N.S.	A4	5H21/32 - 900 rpm - 1 String				01 (01)	
Info. No. :		Description :					Ident. No. :
		HEAT CALCULATION DIAGRAM					B94-017050-6

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use as original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to his effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.
이 도면은 현대중공업의 재산이므로 음사와 승인없이 이도면을 제3자에게 양도, 복사, 판매 해거나, 이도면외의 부품을 제작하여 제3자에게 판매하는 것은 불법입니다.



Type H21/32	Unit	5 Cyl.	6 Cyl.	7 Cyl.	8 Cyl.	9 Cyl.
Min.level H1	mm	320	320	320	320	320
Max.level H2	mm	400	400	400	400	400
Min.volume	liter	750	840	940	1080	1140
Max.volume	liter	930	1040	1170	1350	1420

Standard for surface roughness (ISO 1302-1978)		Supplement Dwg no.:		Projection:		Mass (kg):		Material / Blank:	
Close No. N1 N2 N3 N4 N5 N6 N7 N8 N9 N10 N11 N12				Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:	
R max. (μm) 0.025 0.05 0.1 0.2 0.4 0.8 1.6 3.2 6.3 12.5 25 50		Date		Des.		Chk.		Appd.	
Tolerances for dimensions without tolerance indication (ISO 2768-1989)		A.C.		E		Change / Replacement		C.No	
0.5 over 30 up to 60		*		*		Replaced by Ident. No.:		9	
0.5 over 60 up to 120		*		*				8	
0.5 over 120 up to 250		*		*				7	
0.5 over 250 up to 500		*		*				6	
0.5 over 500 up to 1000		*		*				5	
0.5 over 1000 up to 2000		070608		KKH		KSR		KSR	
0.5 over 2000 up to 4000		041203		GJH		RYS		RYS	
0.5 over 4000 up to 8000		031208		GJH		RYS		RYS	
0.5 over 8000 up to 16000		030610		GJH		KSR		KSR	
0.5 over 16000 up to 32000		011029		PDS		PDS		LJH	
0.5 over 32000 up to 64000									
0.5 over 64000 up to 128000									
0.5 over 128000 up to 256000									
0.5 over 256000 up to 512000									
0.5 over 512000 up to 1024000									
0.5 over 1024000 up to 2048000									
0.5 over 2048000 up to 4096000									
0.5 over 4096000 up to 8192000									
0.5 over 8192000 up to 16384000									
0.5 over 16384000 up to 32768000									
0.5 over 32768000 up to 65536000									
0.5 over 65536000 up to 131072000									
0.5 over 131072000 up to 262144000									
0.5 over 262144000 up to 524288000									
0.5 over 524288000 up to 1048576000									
0.5 over 1048576000 up to 2097152000									
0.5 over 2097152000 up to 4194304000									
0.5 over 4194304000 up to 8388608000									
0.5 over 8388608000 up to 16777216000									
0.5 over 16777216000 up to 33554432000									
0.5 over 33554432000 up to 67108864000									
0.5 over 67108864000 up to 134217728000									
0.5 over 134217728000 up to 268435456000									
0.5 over 268435456000 up to 536870912000									
0.5 over 536870912000 up to 1073741824000									
0.5 over 1073741824000 up to 2147483648000									
0.5 over 2147483648000 up to 4294967296000									
0.5 over 4294967296000 up to 8589934592000									
0.5 over 8589934592000 up to 17179869184000									
0.5 over 17179869184000 up to 34359738368000									
0.5 over 34359738368000 up to 68719476736000									
0.5 over 68719476736000 up to 137438953472000									
0.5 over 137438953472000 up to 274877906944000									
0.5 over 274877906944000 up to 549755813888000									
0.5 over 549755813888000 up to 1099511627776000									
0.5 over 1099511627776000 up to 2199023255552000									
0.5 over 2199023255552000 up to 4398046511104000									
0.5 over 4398046511104000 up to 8796093022208000									
0.5 over 8796093022208000 up to 17592186044416000									
0.5 over 17592186044416000 up to 35184372088832000									
0.5 over 35184372088832000 up to 70368744177664000									
0.5 over 70368744177664000 up to 140737488355328000									
0.5 over 140737488355328000 up to 281474976710656000									
0.5 over 281474976710656000 up to 562949953421312000									
0.5 over 562949953421312000 up to 1125899906842624000									
0.5 over 1125899906842624000 up to 2251799813685248000									
0.5 over 2251799813685248000 up to 4503599627370496000									
0.5 over 4503599627370496000 up to 9007199254740992000									
0.5 over 9007199254740992000 up to 18014398509481984000									
0.5 over 18014398509481984000 up to 36028797018963968000									
0.5 over 36028797018963968000 up to 72057594037927936000									
0.5 over 72057594037927936000 up to 144115188075855872000									
0.5 over 144115188075855872000 up to 288230376151711744000									
0.5 over 288230376151711744000 up to 576460752303423488000									
0.5 over 576460752303423488000 up to 1152921504606846976000									
0.5 over 1152921504606846976000 up to 2305843009213693952000									
0.5 over 2305843009213693952000 up to 4611686018427387904000									
0.5 over 4611686018427387904000 up to 9223372036854775808000									
0.5 over 9223372036854775808000 up to 18446744073709551616000									
0.5 over 18446744073709551616000 up to 36893488147419103232000									
0.5 over 36893488147419103232000 up to 73786976294838206464000									
0.5 over 73786976294838206464000 up to 147573952589676412928000									
0.5 over 147573952589676412928000 up to 295147905179352825856000									
0.5 over 295147905179352825856000 up to 590295810358705651712000									
0.5 over 590295810358705651712000 up to 1180591620717411303424000									
0.5 over 1180591620717411303424000 up to 2361183241434822606848000									
0.5 over 2361183241434822606848000 up to 4722366482869645213696000									
0.5 over 4722366482869645213696000 up to 9444732965739290427392000									
0.5 over 9444732965739290427392000 up to 18889465931478580854784000									
0.5 over 18889465931478580854784000 up to 37778931862957161709568000									
0.5 over 37778931862957161709568000 up to 75557863725914323419136000									
0.5 over 75557863725914323419136000 up to 151115727451828646838272000									
0.5 over 151115727451828646838272000 up to 302231454903657293676544000									
0.5 over 302231454903657293676544000 up to 604462909807314587353088000									
0.5 over 604462909807314587353088000 up to 1208925819614629174706176000									
0.5 over 1208925819614629174706176000 up to 2417851639229258349412352000									
0.5 over 2417851639229258349412352000 up to 4835703278458516698824704000									
0.5 over 4835703278458516698824704000 up to 9671406556917033397649408000									
0.5 over 9671406556917033397649408000 up to 19342813113834066795298816000									
0.5 over 19342813113834066795298816000 up to 38685626227668133590597632000									
0.5 over 38685626227668133590597632000 up to 77371252455336267181195264000									
0.5 over 77371252455336267181195264000 up to 154742504910672534362390528000									
0.5 over 154742504910672534362390528000 up to 309485009821345068724781056000									
0.5 over 309485009821345068724781056000 up to 618970019642690137449562112000									
0.5 over 618970019642690137449562112000 up to 1237940039285380274899124224000									
0.5 over 1237940039285380274899124224000 up to 2475880078570760549798248448000									
0.5 over 2475880078570760549798248448000 up to 4951760157141521099596496896000									
0.5 over 4951760157141521099596496896000 up to 9903520314283042199192993792000									
0.5 over 9903520314283042199192993792000 up to 19807040628566084398385987584000									
0.5 over 19807040628566084398385987584000 up to 39614081257132168796771975168000									
0.5 over 39614081257132168796771975168000 up to 79228162514264337593543950336000									
0.5 over 79228162514264337593543950336000 up to 158456325028528675187087900672000									
0.5 over 158456325028528675187087900672000 up to 316912650057057350374175801344000									
0.5 over 316912650057057350374175801344000 up to 633825300114114700748351602688000									
0.5 over 633825300114114700748351602688000 up to 1267650600228229401496703205376000									
0.5 over 1267650600228229401496703205376000 up to 2535301200456458802993406410752000									
0.5 over 2535301200456458802993406410752000 up to 5070602400912917605986812821504000									
0.5 over 5070602400912917605986812821504000 up to 10141204801825835211973625643008000									
0.5 over 10141204801825835211973625643008000 up to 20282409603651670423947251286016000									
0.5 over 20282409603651670423947251286016000 up to 40564819207303340847894502572032000									
0.5 over 40564819207303340847894502572032000 up to 81129638414606681695789005144064000									
0.5 over 81129638414606681695789005144064000 up to 162259276829213363391578010288128000									
0.5 over 162259276829213363391578010288128000 up to 324518553658426726783156020576256000									
0.5 over 324518553658426726783156020576256000 up to 649037107316853453566312041152512000									
0.5 over 649037107316853453566312041152512000 up to 1298074214633706907132624082305024000									
0.5 over 1298074214633706907132624082305024000 up to 2596148429267413814265248164610048000									
0.5 over 2596148429267413814265248164610048000 up to 5192296858534827628530496329220096000									
0.5 over 5192296858534827									

PLAN HISTORY					ENGINE TYPE	HYUNDAI-HiMSEN H17/28, H21/32, H25/33, H32/40
					MESSRS	ENGINE BUYER
TITLE : Lubricating oil chart (SAE 40) Page 1/10 : Cover page Page 2/10 ~ 5/10 : Lubricating oil specification for H17/28, H21/32, H25/33, H32/40 Page 6/10 ~ 9/10 : Lubricating oil specification for Woodward governor Page 10/10 : List of lubricating oil						
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	
				*		
				*		
				*		
				*		
070709	KCM	KKS	SJR	*	Rev. page: 6/10 ~ 10/10	
050808	KCM	LJH	SJR	*	First issue	
Similar drawing No.:					Replacement for Ident. No.:	
Licensor Ident. No.:				Type:		
Info. No.:				H17/28, H21/32, H25/33, H32/40		
Page. No.: 01 OF 10				Description: Lubricating oil chart (SAE 40)		
						Ident.no.: B94-015292-3

		All type	Page 1/4
Lubricating Oil and Its Control	Lubricating Oil Specification	Section No.	Rev.
윤활유 및 관리	윤활유 사양	G06100	1B

1. 윤활유의 품질

윤활유는 엔진 시스템에 있어서 중요한 역할을 하며 다음과 같이 요약될 수 있다.

- 마찰력과 마모를 줄이기 위한 미끄럼 부분의 윤활
- 엔진 부품들의 냉각 (피스톤, 베어링 등)
- 피스톤 링의 시일링
- 세정제의 분산
- 연소 부산물의 중화

따라서 엔진 시스템 오일은 사용연료와 운전조건에 따라 이러한 기능을 충족시키는 것을 선택하여야 한다. 추천할 만한 윤활유 상표는 별도로 목록이 되어 있고 새로운 윤활유의 기본적인 구비조건은 아래와 같다

1. Quality of Lubricating Oil

Lubricating oil has significant roles for the engine system, which can be summarized as below;

- Lubrication of the sliding parts to reduce friction and wear.
- Cooling of the engine parts (piston, bearing, etc).
- Sealing of piston ring.
- Dispersion of detergent.
- Neutralization of combustion by products.

Therefore, engine system oil should be selected to fulfill these functions depending on the fuel used and the operating condition. The recommendable brand names of the lubricants are listed separately and the basic requirements of new oil are as follows:

Oil grade	API service grade CD (MIL-L/2104C and D) for heavy duty marine diesel engine.
Viscosity	SAE 40(120-180 cSt @40 °C)
Flash Point	Over 220 °C
Pour Point	-15 °C

BN은 연료 등급과 아래와 같은 황 함유량에 따라 세심하게 선택 되어야 한다

BN (Base Number, Alkalinity) should be selected carefully depending on the fuel grade and sulfur contents as follow:

Fuel grade	Sulfur content (% m/m)	BN
MGO/MDO	Up to 0.2	10 - 15
MGO/MDO/HFO	0.2 – 1.5	10 - 20
HFO	1.5 – 2.5	20 - 30
HFO	2.5 – 3.5	30 - 40
HFO	3.5 – 4.5	40 - 55

▲ 경 고 윤활유를 다른 종류와 혼합하지 마십시오.
혼합되면 엔진에 심각한 문제가 발생할 수 있습니다.

▲ WARNING Do not mix the lubricating oil with different brands, which may cause serious problem on the engine.



		All type	Page 2/4
Lubricating Oil and Its Control	Lubricating Oil Specification	Section No.	Rev.
윤활유 및 관리	윤활유 사양	G06100	1B

2. 윤활유 상태 점검

윤활유 품질은 다양한 발생원에 의해 노화 및 오염물로 인해 차츰 변화될 것이다. 전형적인 오염물은 연소실의 검정분진 및 소립자, 스며든 응축수, 소금기, 파손된 소립자 그리고 오일 자체의 산화물들이다.

그러므로, 공급자 또는 전문가에 의한 윤활유 상태의 규칙적인 점검은 적어도 3개월 마다 하는 것이 강력 추천된다. 이 경우에 점도, 인화점, BN, 불용성 및 수분성분과 특성에 대한 분석이 점검에 포함되어야 한다.

실험실 점검사이의 기간동안에는 윤활유 공급자가 권고하는 간단한 시험 방법이 윤활유 품질에 대한 유익한 정보를 제공 할 것이다.

점검을 위한 오일의 올바른 샘플링은 분석에 대한 정확한 평가를 하는데 결정적인 요소이다. 견본 오일은 엔진가동 중에 여과된 후에 취해져야 하며 견본 오일의 용기는 샘플링 되기 전에 매우 깨끗해야 한다.

모든 점검결과는 경향 평가가 기록되고 남겨져서 신뢰성 있는 엔진 운전에 도움이 되어야 한다.

2. Checking of Lubricating Oil Condition

The quality of the lubricating oil will be changed slowly due to ageing and contamination via various sources. The typical contaminants are soot and particles from combustion chamber, penetrated or condensed water and salt, wear particles, and oxidation of oil itself, etc.

Therefore, regular checking of lubricating oil condition by supplier or specialist, at least every three months interval, is strongly recommended. In this case, the checking should include at least the analysis of Viscosity, Flash point, BN, insoluble, and water content and the nature.

During the intervals between laboratory checking, a simple test method proposed by oil supplier will be also informative on the quality of oil.

Correct sampling of oil for checking is critical for correct evaluation of the analysis. The sample oil should be taken after the filter during engine running. The container for sample oil should be cleaned thoroughly before sampling.

All checking results should be recorded and kept for trend evaluation, which contribute to reliable engine operation.

		All type	Page 3/4
Lubricating Oil and Its Control	Lubricating Oil Specification	Section No.	Rev.
윤활유 및 관리	윤활유 사양	G06100	1B

3. 윤활유의 조건

엔진 내 윤활유의 상태는 다음의 범주 내에 있는 것이 추천된다.

3. Condition of Lubricating Oil

The condition of lubricating oil inside the engine is recommended to be within the following range;

Ingredients	Tolerable range	Test method
BN:	max. 50 % of initial value.	ISO 3771
Viscosity	min. -20 % and max. 30 % of new oil.	ISO 3104
Flash Point	min. 180 ℃	ISO 2719
Water content	below 0.3 %(volume)	ISO 3733
n-Pentan insoluble	max. 2.5 %(mass)	ASTM D-893/B

윤활유의 상태는 독립 변수가 아니라 전체적인 것으로 평가되어야 한다. 윤활유의 교체 또는 충전은 해석결과에 기초한 오일 공급자의 의견을 물도록 하고 있다.

매개 변수들의 돌연한 변화는 엔진의 비정상적인 운전 상태나 시스템의 기능 장애를 나타낼 수 있으므로 그 원인 조사와 오류 조치는 윤활유의 교체에 앞서 실시되어야 한다.

어떤 변수가 허용한계에 있다면 오일을 전면 교체하는 대신 일부 방법들로 오일을 정상상태로 바꾸는데 효과가 있을 수 있다. 어떤 경우에 이러한 것은 적절한 처리나 강력한 정제작용 또는 오일을 부분적으로 충전함으로써 달성될 수 있다

The condition of the lubricating oil should be evaluated not by a single parameter but as a whole. Replacement or filling of the lubricating oil is recommended to consult the oil supplier based on the analysis results.

As a sudden change of parameters may indicate abnormal operating condition or malfunction of the system, investigating the cause and remedying the fault should precede replacing the lubricating oil.

If any parameter reaches tolerable limit, some measures instead of entire replacement of the oil may be effective for recovering the oil to normal condition. In some cases, this can be achieved by proper treatment or by intensive purification or by partial filling of the oil.

▲ 경 고 인화점이 150℃ 미만이면 크랭크 케이스의 폭발 위험이 있을 수 있습니다.

▲ WARNING If flash point is below 150 ℃, there may be a risk of crank case explosion.

		All type	Page 4/4
Lubricating Oil and Its Control	Lubricating Oil Specification	Section No.	Rev.
윤활유 및 관리	윤활유 사양	G06100	1B

4. 윤활유의 정제

엔진 필터에 추가하여 윤활유에 정제장치를 설치하도록 권고하고 있다.

부착된 원심분리 필터는 경유로 운전하는 엔진에 추천된다. 원심형 정제장치는 중유로 운전하는 엔진에 필요하다.

저 점도를 만들기 위해서 가열된 윤활유를 계속해서 원심 분리하도록 권고하는 것은 보다 효과적인 정제작업을 위한 것이다. 유량과 예열온도에 대해서는 정제 장비 메이커의 권고사항을 따르도록 하고 있다. (보통 85~95 ℃)

엔진 운전 중인 동안에는 계속해서 윤활유를 원심 분리 하는 것을 추천한다. 이것은 윤활유가 공급 될 때 윤활유 속에 포함 된 이물질이 즉시 제거 될 수 있다. 동시에 윤활유를 예열 하는데 적은 양이 필요하기 때문에 에너지 절감 할 수 있는 방법이기도 하다.

여러 대의 엔진에 한 대의 원심 분리가 설치 되는 경우는 한 번에 한 대의 엔진만 연결하여야 한다. 이것은 한 엔진으로부터 다른 엔진으로의 윤활유가 흡입 / 배출 되는 것을 방지한다. 모든 엔진의 정제를 위해서는 순차적으로 운전 중인 엔진을 각각 분리하여 정제 하는 것을 추천한다.

알림 일부 경우, 오염과 TBN 수치 저하를 막기 위해 윤활유를 물로 세척하는 것은 허용되지 않습니다.

5. 다른 설비용 윤활유

엔진시스템 오일은 엔진의 구동부와 터보과급기를 포함한다. 그렇지만 유압 가버너는 자체의 규격이 요구되며 지침서에 언급되어 있다.

4. Purifying of Lubricating Oil

In addition to engine filter, it is recommended to install a purifying device for the lubricating oil.

A built on centrifugal filter is recommended for the engine running on marine diesel oil. A centrifugal type purifier is required for the engine running on heavy fuel oil.

Continuous centrifuging with heated lubricating oil for lower viscosity is recommended for more effective purifying. It is recommended to follow the purifier maker's recommendation for the flow rate and preheating temperature (normally 85-95 ℃).

It is recommended to separate the oil on the engine while operating. In this way, the dirt can be removed immediately when it is supplied to the engine. At the same time energy is saved because it is necessary to warm up the oil only by a little.

It only one separator is installed to several engine, it is only connected with one engine at a time. This is to ensure that there is no suction and discharging from one engine to another. It is recommended to split up the time so that there is separation on all engines, which are operating in turns.

NOTICE In any case, cleaning the lubricating oil by water is not allowed to avoid contamination and decreasing of TBN value.

5. Lubricating Oil for Other Machinery

The engine system oil covers moving parts of the engine and turbocharger. However, hydraulic governor requires own specification and refer to the manual for the governor.

Non-linear fuel arrangement lets the governor open the fuel setting more at maximum settings than it does at minimum settings. Woodward application note 50516, *Governor Linkage for Butterfly Throttle Valves*, provides more information about non-linear linkage.

Design the linkage so the power output of the engine is proportional to the position of the governor output shaft.

Follow the engine manufacturer's instructions on linkage selection, installation, and adjustment. In almost all cases, the linkage designed for a UG-8 governor will work with the UG-25⁺. In the case of a direct exchange, make sure that the linkage is in good condition and the installation of the lever on the governor is in the same position as it was on the old governor.

Oil Supply

Use the information given in Figures 2-5 and 2-6 as a guide in the selection of a suitable oil. Oil grade selection is based on the operating temperature range of the governor. Also use this information to aid in recognizing and correcting common problems associated with oil used in the governor. Many operation and maintenance problems associated with UG-25⁺s are directly related to the selection and condition of the oil in the governor. Use care in the selection and make sure that the oil in the governor is not contaminated.

The oil in the UG-25⁺ is both a lubricating and hydraulic oil. It must have a viscosity index that allows it to perform over the operating temperature range and it must have the proper blending of additives that cause it to remain stable and predictable over this range.

The UG-25⁺ is designed to give stable operation with most oils, if the fluid viscosity at the operating temperature is within a 50 to 3000 SUS (Saybolt Universal Seconds) range (see Figure 2-6). Poor governor response or instability is an indication that the oil is too thick or too thin.

Governor oil must be compatible with seal material, that is, nitrile, polyacrylic, and fluorocarbon. Many automotive and gas engine oils, industrial lubricating oils, and other oils of mineral or synthetic origin meet these requirements.

Fill the governor with about 2.1 liters (2.2 quarts) of oil, to a level visible in the oil sight glass. After the engine is started and the governor is at operating temperature, add oil if necessary. Oil must be visible in the glass under all operating conditions.

Excessive component wear or seizure in the governor indicates the possibility of:

1. Insufficient lubrication caused by:
 - an oil that flows slowly when it is cold, especially during start-up;
 - no oil in the governor.
2. Contaminated oil caused by:
 - dirty oil containers;
 - an governor exposed to heating and cooling cycles, which created condensation of water in the oil.
3. Oil not suitable for the operating conditions caused by:
 - changes in ambient temperature;
 - an improper oil level which creates foamy, aerated oil.

UG-25* Installation and Operation

Manual 26330

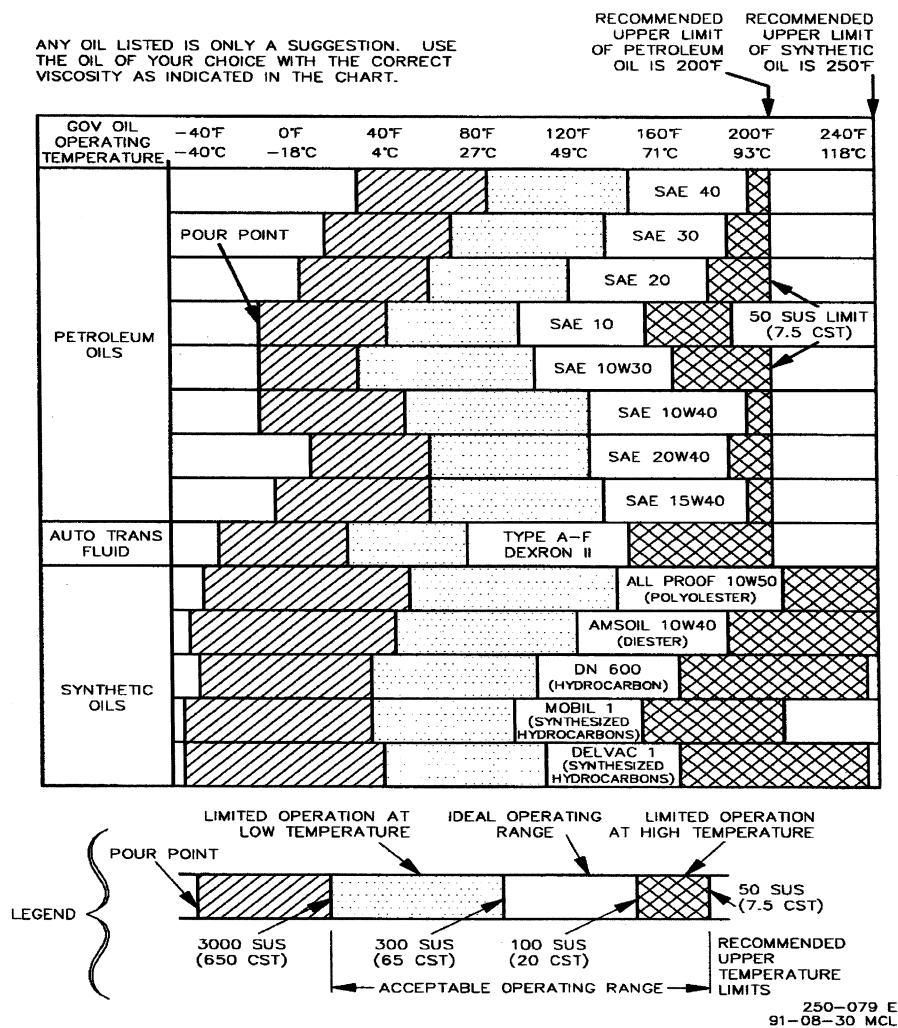


Figure 2-5. Oil Chart

Operating an governor continuously beyond the high limit temperature of the oil will result in oil oxidation. This is identified by varnish or sludge deposits on the governor parts. To reduce oil oxidation, lower the governor operating temperature with a heat exchanger or other means, or change to an oil more oxidation-resistant at the operating temperature.

**WARNING—OVERSPEED**

To prevent possible serious injury or loss of life, or damage to the engine, resulting from engine overspeed or a runaway engine, be sure to use only oil that falls within the 50 to 3000 SUS range. Using oils outside this range could cause the governor to be unable to prevent a runaway engine.

VISCOSITY COMPARISONS				
CENTISTOKES (CST, CS, OR CTS)	SAYBOLT UNIVERSAL SECONDS (SUS) NOMINAL AT 100 DEGREES F	SAE MOTOR (APPROXIMATE)	SAE GEAR (APPROXIMATE)	ISO
15	80	5W		15
22	106	5W		22
32	151	10W	75	32
46	214	10	75	46
68	310	20	80	68
100	463	30	80	100
150	696	40	85	150
220	1020	50	90	220
320	1483	60	115	320
460	2133	70	140	460

250-087
97-11-04 skw

Figure 2-6. Viscosity Comparisons

Oil Maintenance

Replace the governor oil if it is contaminated, and change it if it is suspected of contributing to instability. Drain the oil while it is still hot. Flush the governor with a clean solvent having some lubricating quality (fuel oil or kerosene) before refilling with new oil. If drain time is insufficient for the solvent to completely drain or evaporate, flush the governor with the same oil it is being refilled with to avoid dilution and possible contamination of the new oil.

Oil that has been carefully selected to match the operating conditions and is compatible with governor components should give long service between oil changes. Check oil conditions regularly and change oil if any deterioration or contamination is suspected.

Regularly scheduled oil changes will extend the life of the governor and improve governor operation. Properly selected oil should permit annual oil changes, but more frequent changes are recommended.



WARNING—EXPLOSION HAZARD

Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2.



AVERTISSEMENT—RISQUE D'EXPLOSION

Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous vous situez bien dans une zone non explosive.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2.

**CAUTION—WIRING**

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 3-1a and 3-1b).

Electrical Connection

The electrical connector on the UG-25⁺ is a 30-pin Cinch connector (581-01-30-029S). Seal plugs are required for all unused pins. The mating connector kits can be ordered from Woodward. see Chapter 3 for electrical connection details.

Heat Exchanger

A heat exchanger is not available for the UG-25⁺.



Lubricating Oil and Its Control		All type	Page 1/1
List of Lubricating Oil		Section No.	Rev.
윤활유 및 관리		G06200	1C
윤활유 목록			

Oil brand	Engine system lubricating oil				Governor oil (Woodward UG 25+)
Oil company	Brand name	SAE	BN	Fuel grade	
Shell	Shell Gadinia 40	40	12	A, B	Same as Engine system Lub. Oil
	Shell Argina S 40		20	B, C	
	Shell Argina T 40		30	C, D	
	Shell Argina X 40		40	D, E	
	Shell Argina XL 40		50	E	
Total (Lubmarine)	DISOLA M 4012	40	12	A, B	
	DISOLA M 4015		14	A, B	
	DISOLA M 4020		20	B, C	
	AURELIA XL 4030		30	C, D	
	AURELIA XL 4040		40	D, E	
	AURELIA XL 4055		55	E	
	AURELIA TI 4030		30	C, D	
	AURELIA TI 4040		40	D, E	
	AURELIA TI 4055		55	E	
FAMM (TEXACO+Chevron)	DELO 1000 Marine 40	40	12	A, B	
	TARO 20 DP 40		20	B, C	
	TARO 30 DP 40		30	C, D	
	TARO 40 XL 40		40	D, E	
	TARO 50 XL 40		50	E	
ExxonMobil (Exxon+Mobil)	Mobilgard 412	40	15	A, B	
	Mobilgard M430		30	C, D	
	Mobilgard M440		40	D, E	
BP Amoco (BP+Castrol)	BP ENERGOL DL-MP 40	40	9	A, B	
	BP ENERGOL DS3-154		15	A, B	
	CASTROL MLC 40		12	A, B	
	CASTROL MHP 154		15	A, B	
	BP IC-HFX 204		20	B, C	
	BP IC-HFX 304		30	C, D	
	BP IC-HFX 404		40	D, E	
	BP IC-HFX 504		50	E	
	CASTROL TLX PLUS 204		20	B, C	
	CASTROL TLX PLUS 304		30	C, D	
	CASTROL TLX PLUS 404		40	D, E	
SK	SUPERMAR 13TP 40	40	13	A, B	
	SUPERMAR 24TP 40		24	C	
	SUPERMAR 30TP 40		30	C, D	
	SUPERMAR 40TP 40		40	D, E	
Oil volume	See separate data for sump volume as per each engine type.				2.1 Liter

*) This list is given as guidance only.

Fuel grade

A: Distillate fuels (MGO or MDO)
(S: Max 0.2% m/m)

B: Distillate fuels (MGO or MDO)
(S: 0.2 ~ 1.5% m/m)

or

Residual fuels (HFO)
(S: 0.2 ~ 1.5% m/m)

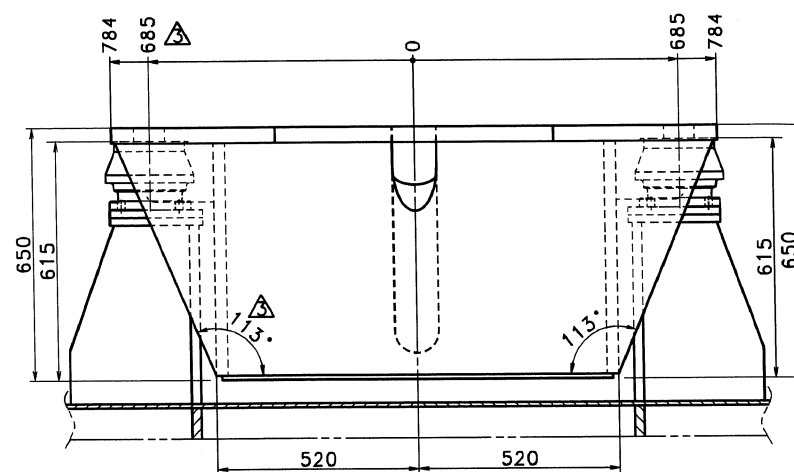
C: Residual fuels (HFO)
(S: 1.5 ~ 2.5% m/m)

D: Residual fuels (HFO)
(S: 2.5 ~ 3.5% m/m)

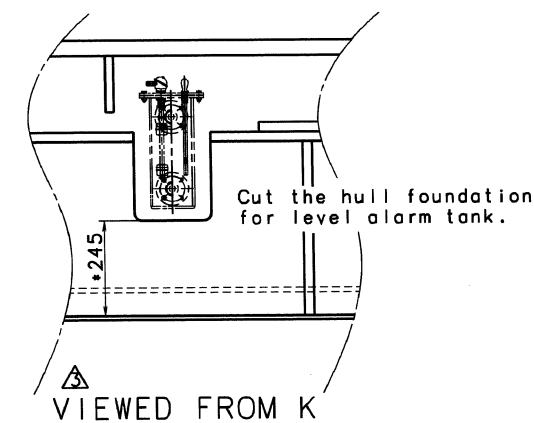
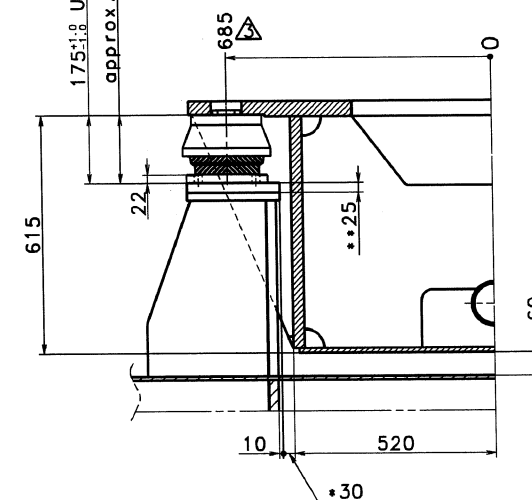
E: Residual fuels (HFO)
(S: 3.5 ~ 4.5% m/m)

*) Lubricating oil quantity (Initial filling: Oil empty, Without oil overflow system)

Engine type	Engine rpm	Lubricating Oil Quantity (Max. volume), Unit : Liter				
		5 cyl.	6 cyl.	7 cyl.	8 cyl.	9 cyl.
H17/28	900 / 1000 rpm	530	620	700	780	-
H21/32	720 / 750 rpm	820	950	1070	1180	1270
	900 / 1000 rpm	930	1040	1170	1350	1420
H25/33	720 / 750 rpm	-	1240	1380	1530	1670
	900 / 1000 rpm	-	1460	1630	1800	1970
H32/40	720 / 750 rpm	-	2730	3200	3600	4010



175^{+1.0} UNLOADED



- This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available, either third party without written consent of the affiant from HHI-EMD. The material must not be transferred by any other third party without written consent of the affiant from HHI-EMD.
- 이 도면과 그 보충서류는 HHI-EMD의 소유이며 저작권에 의해 보호됩니다. 이 도면은 수탁자에게 오직 본인이 필요로 하는 HHI-EMD의 제품 제조, 수리 또는 사용만을 위하여 제공되며, HHI-EMD와 수탁자 사이에 체결된 계약서나 다른 서면 합의에 의거하여만 HHI-EMD의 제품 제조, 수리 또는 사용에 사용될 수 있습니다. 이 도면은 HHI-EMD의 사전 서면 동의 없이 전체 또는 부분적으로 복제, 재생산, 배포, 공표 또는 다른 방법으로 제3자에게 제공될 수 없습니다. 이 도면은 HHI-EMD의 사전 서면 동의 없이 제3자에게 양도될 수 없습니다.

Standard for surface roughness												
The basic symbols and close numbers are in accordance with ISO 1302-1978.												
Close No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _{max} , μgine μm	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768-1988)						
This standard states the permissible deviations for dimensions without direct tolerances (indicated on metallic components manufactured by machining)						
No. measurement mm	0,3	over 0,3	over 30	over 120	over 318	over 1000
Permissible deviations	up to 6	up to 30	up to 120	up to 318	up to 1000	up to
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,0

Supplement Drawing No.:						Projection		Mass (kg)		Material / Blank:	
						Licensor's Ident. No.:		Dist.:		Licensor's Material / Blank:	
								AB2			
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					
					*	* Replaced by Ident. No.:					
					*						
					*						
					*						
					*						
					*						
080130	KKH	KCS	KCS	*	*	* Modified direction of view X					
071126	KKH	RYS	RYS	*	*	* Modified Min. necessary distance & Width of mounting					
071029	KKH	RYS	RYS	*	*	* Modified & added to Min. necessary distance					
070908	KKH	KSR	KSR	*	*	* Modified position of 4th mounting					
070816	KKH	KSR	KSR	*	*						
Similar Drawing No.:						Replacement for Ident. No.:					
Scale:	Size:	Type:				Page No.:					
1:0.8	A0		5H20/32 900RPM			01 (01)					
Info. No.:		Description:				Ident. No.:					
A.11.100		HOLDING DOWN BOLT ARRANGEMENT				B90-027333-					

Resilient Mounting of Generating Sets

On resiliently mounted generating sets the diesel engine and the alternator are placed on a common rigid base frame mounted on the vessel's/engine rooms's foundation by means of resilient supports, type conical.

All connections from the generating set to the external systems should be equipped with flexible connections and pipes. Gangway etc. must not be welded to the external part of the installation.

Resilient support

Resilient mounting of the generating set is made with a number of conical mountings. The number and the distance between them depend on the size of the plant. These conical mountings are bolted to brackets on the base frame, see fig 1.

The setting from unload to load condition is normally 4-12mm for the conical mounting.

The support of the individual conical mounting can be made in one of the following two ways.

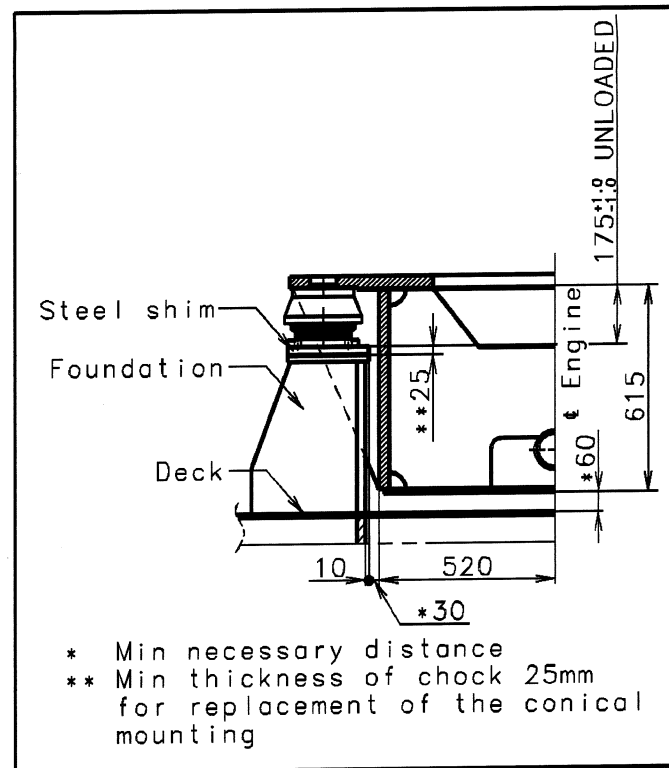


Fig 1. Resilient Mounting of Generating Sets

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to his effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.												
이 도면과 그 보충 도면은 HHI-EMD의 재산이며 저작권의 보호를 받는다. 이 도면은 HHI-EMD의 제품 제조, 수리 또는 사용만을 위하여 HHI-EMD와 계약 또는 다른 서면 합의에 따라 HHI-EMD에게만 제공되며, 오직 HHI-EMD의 제품만을 위한 사용에 한정된다. 이 도면의 내용을 전부 또는 일부가 사본, 복제, 배포, 공표 또는 다른 방법으로 제3자에게 제공되거나, HHI-EMD의 동의 없이 제3자에게 양도, 대여, 판매 또는 기타 방법으로 제3자에게 제공되는 것을 금지한다. 이 도면의 내용을 제3자에게 제공하거나, HHI-EMD의 동의 없이 제3자에게 양도, 대여, 판매 또는 기타 방법으로 제3자에게 제공되는 것을 금지한다.												
Standard for surface roughness						Tolerances for dimensions without tolerance indication (ISO 2768-1989)						
The basic symbols and class numbers are in accordance with ISO 1302-1978.						This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.						
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max.	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50
	Nom. measurement					0,5	over 0,5	over 30	over 120	over 315	over 1000	over 2000
	Permissible deviations					±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	
	Medium series											

Supplement Drawing no.:					Projection:		Mass (kg):		Material / Blank:		
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					C.No
					*	Replaced by Ident. No.:					9
					*						8
					*						7
					*						6
					*						5
					*						4
					*						3
					*						2
					*						1
					*	Modified design of hull foundation					0
					*	YOUIL CONICAL MOUNTING					0
071205KKHRYSRYS						070823KKHKSRKSR					
Similar Drawing No.:						Replacement of Ident. No.:					
Scale:		Size:		Type:		Page No.:		HYUNDAI			
NS.		A3		H21/32, H25/33		01 (03)		HEAVY INDUSTRIES CO., LTD.			
Info. No.:		Description:		Ident. No.:							
000000		INSTRUCTION FOR RESILIENT MOUNT		B93-027341-9							

1. The support between the bottom flange of the conical mounting and the foundation is made with a loose steel shim. This steel shim is adjusted to an exact measurement (min. 25mm) for each conical mounting.

2. The support can also be made by means of two steel shims at the top a loose steel shim of at least 25mm and below a steel shim of at least 10mm which is adjusted for each conical mounting and then welded to the foundation.

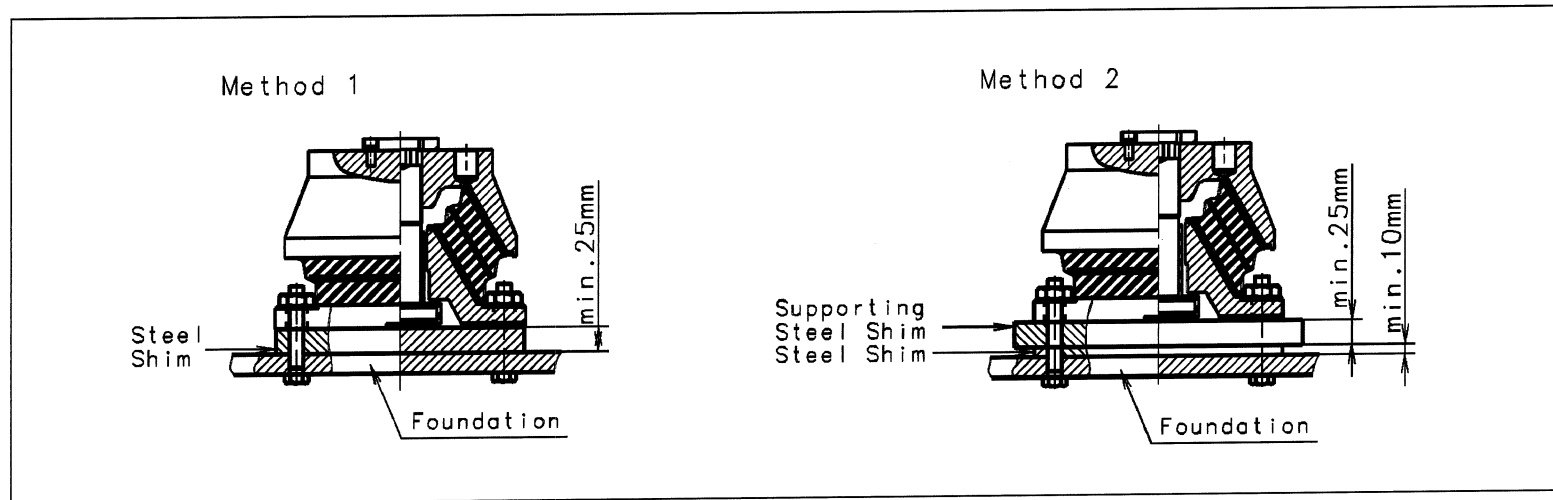


Fig 2. Support of Conicals

Supplement Drawing no.:						Projections:		Mass (kg):		Material / Blank:		
						Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement						C.No
				*	*	Replaced by Ident. No.:						9
				*	*							8
				*	*							7
				*	*							6
				*	*							5
				*	*							4
				*	*							3
				*	*							2
				*	*							1
				*	*	Modified design of hull foundation						0
071205KKHRYSRYS						070823KKHKSRKSR						0
Similar Drawing No.:						Replacement of Ident. No.:						
Scale:	Size:	Type:	Page No.:			HYUNDAI HEAVY INDUSTRIES CO., LTD.						
NS.	A3	H21/32, H25/33	02 (03)									
Info. No.:						Description:						Ident. No.:
000000						INSTRUCTION FOR RESILIENT MOUNT						B93-027341-9

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement between HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to his effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

이 도면 및 도면상의 기술은 HHI-EMD의 재산으로 HHI-EMD의 허락 없이 제3자에게 제공, 복제, 배포, 대여, 판매, 전매, 임대, 대여, 또는 기타 방법으로 제3자에게 제공될 수 없습니다.

Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1302-1978.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value μm	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768-1989)						
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.						
Nom. measurement mm	0,5	over 0,5	over 30	over 120	over 315	over 1000
Permissible deviations	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

Irrespective of the method of support the 25mm steel shim is necessary to facilitate a possible future replacement of the conical mountings which are always replaced in pairs.

Adjustment of Engine and Alternator on Base Frame

The resiliently mounted generating set is normally delivered from the factory with engine and alternator mounted on the common base frame. Eventhough, engine and alternator have been adjusted by the factory with the alternator rotor placed correctly in the stator, and the crankshaft bend of the engine within the prescribed tolerances, it is recommended to check the crankshaft deflection before starting up the plant.

Supplement Drawing no.:						Projection: 		Mass (kg):		Material / Blank:		
						Licensor's Ident. no.:		Diel.:		Licensor's Material / Blank:		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement						C.No
				*	*	Replaced by Ident. No.:						9
				*	*							8
				*	*							7
				*	*							6
				*	*							5
				*	*							4
				*	*							3
				*	*							2
				*	*							1
071205KKHRYSRYS						*	*	Modified design of hull foundation				0
070823KKHKSRKSR						*	*	YOUIL CONICAL MOUNTING				0
Similar Drawing No.:						Replacement of Ident. No.:						
Scale:		Size:		Type:		Page No.:		HYUNDAI HEAVY INDUSTRIES CO., LTD.				
NS.		A3		H21/32, H25/33		03 (03)						
Info. No.:						Description:						Ident. No.:
000000						INSTRUCTION FOR RESILIENT MOUNT						B93-027341-9

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use as original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to his effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.												
이 도면은 HHI-EMD의 재산으로 설계의 저작권이 HHI-EMD에 속하며, 이 도면은 HHI-EMD의 제품 제조, 수리, 사용 용도로만 사용될 수 있습니다. HHI-EMD의 사전 서면 동의 없이 이 도면의 내용을 복사, 복제, 배포하거나 제3자에게 제공해서는 안 됩니다. 이 도면의 내용을 제3자에게 제공하거나 제3자에게 양도, 판매, 임대, 대여, 또는 기타 형태로 제공해서는 안 됩니다.												
Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1302-1976.												
Tolerances for dimensions without tolerance indication (ISO 2768-1989)												
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max.	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
Permissible deviations	Medium series											
	Nom. measurement											
	mm											
	up to 6											
	up to 30											
	up to 120											
	up to 315											
	up to 1000											
	up to 2000											
	±0.1											
	±0.2											
	±0.3											
	±0.5											
	±0.8											
	±1.2											

Mounting and Adjustment Instructions for New Generating Sets (Method 1)

Preparations for Adjustment of Conical Elements

If the conical elements have not been mounted by the factory, they must be mounted on the prepared brackets on the base frame. In case they have been mounted by the factory, please start with item no.2

1. Fit the conical elements to the bracket on the suspended equipment by means of four bolts screwed into the tapped holes on the top casting(3), see fig 1.
2. Remove fixing bolts(6), spring washer(5) and top lock ring(4) from the conical element, see fig 1.
3. Position the four jacking bolts in the tapped holes(7), in the bottom flange, see fig 1.
4. Position the jacking bolts with a through-going of minimum 25mm, see fig 2.
5. Lower the generating set until it rests completely on the foundation.
6. Check that all jacking bolts have full contact with the foundation.
7. Turn all the internal buffers(2) in order to check that they move freely, see fig 1.

- Pos. 1 Base casting
Pos. 2 Internal buffer
Pos. 3 Top casting
Pos. 4 Top lock ring
Pos. 5 Spring washer
Pos. 6 Fixing bolt
Pos. 7 Tapped hole M14

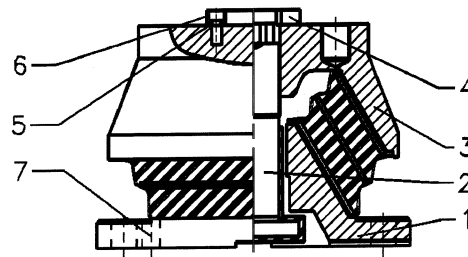


Fig 1. Conical element

Supplement Drawing no.:					Projections:		Mass (kg):	Material / Blank:
					Licensor's Ident. no.:		Dist.:	Licensor's Material / Blank:
							A82	
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement		C.No
				*	*	Replaced by Ident. No.:		9
				*	*			8
				*	*			7
				*	*			6
				*	*			5
				*	*			4
				*	*			3
				*	*			2
				*	*			1
080604KHOKCSKCS					*	*	Changed note no.8	
050411GJHRYRSYS					*	*	YOUIL CONICAL MOUNTING	0
Similar Drawing No.:					Replacement of Ident. No.:			
Scale:	Size:	Type:	Page No.:		HYUNDAI HEAVY INDUSTRIES CO., LTD.			
NS.	A3	ALL TYPE	01 (04)					
Info. No.:					Description:		Ident. No.:	
000000					INSTRUCTION FOR RESILIENT MOUNT		B93-012758-4	

If all internal buffers	Then
move freely	let conical element settle for 48 hours.
cannot be moved freely	turn the jacking bolts clockwise to release the internal buffer.

Adjustment of Conical Elements after 48 Hours Settling

After the conical elements have been deflected under static load for 48 hours, the load height(H1) should be measured and compared to the recommended load height, see fig 2.

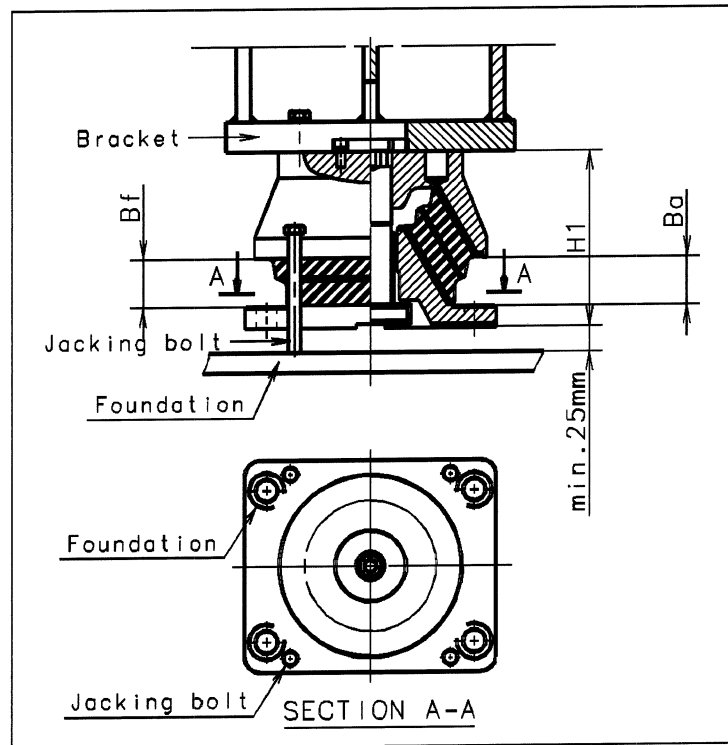


Fig 2.

Supplement Drawing no.:					Projection:	Mass (kg):	Material / Blank:	
					Licensor's Ident. no.:	Dist.:	Licensor's Material / Blank:	
					A82			
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement		C.No
				*	*	Replaced by Ident. No.:		9
				*	*			8
				*	*			7
				*	*			6
				*	*			5
				*	*			4
				*	*			3
				*	*			2
				*	*			1
				*	*			0
080604KHOKCSKCS					*	Changed note no.8		
050411GJHRYSRYS					*	YOUIL CONICAL MOUNTING		
Similar Drawing No.:					Replacement of Ident. No.:			
Scale:	Size:	Type:	Page No.:					
NS.	A3	ALL TYPE	02 (04)					
Info. No.:		Description:				Ident. No.:		
000000		INSTRUCTION FOR RESILIENT MOUNT				B93-012758-4		

8. The variation in laden height should not be exceed 2mm and should ideally be less to ensure that individual mountings are not overloaded.

If	Then
the difference exceeds 2mm.	Level the conical element by adjusting the jacking bolts - commencing with the conical element with the largest deviation.
the difference does not exceed 2mm.	The height of the steel shim can be measured.

Also the difference between Bf(f:forward direction) and Ba(a:afterward direction) should not be more than 0.6mm.

Measuring of Steel Shim

9. Measure the steel shim on several points to obtain the highest possible accuracy during preparation.

Fabricating Steel Shim

10. Make sure that the minimum height of the steel shim is 25mm in order to secure a future replacement of the steel shim.

Drill the mounting holes in the steel shim according to the conical base casting dimensions.

Mounting of Complete Steel Shim

11. Turn the internal buffer anti-clockwise until it contacts the base casting to secure the load height of each conical element.

Supplement Drawing no.:					Projection:		Mass (kg):		Material / Blank:			
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:			
							A82					
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					C.No	
				*	*	Replaced by Ident. No.:					9	
				*	*						8	
				*	*						7	
				*	*						6	
				*	*						5	
				*	*						4	
				*	*						3	
				*	*						2	
080604KHOKCSKCS					*	*	Changed note no.8					1
050411GJHRYSRYS					*	*	YOUIL CONICAL MOUNTING					0
Similar Drawing No.:						Replacement of Ident. No.:						
Scale:	Size:	Type:		Page No.:								
NS.	A3	ALL TYPE			03 (04)							
Info. No.:		Description:				Ident. No.:						
000000		INSTRUCTION FOR RESILIENT MOUNT				B93-012758-4						

CAU Drowning - do not correct by hand

12. Lift the generating sets by means of a crane or a hydraulic jack.
13. Remove all jacking bolts.
14. Position each complete steel shim.
15. Lower the generating set until it rests completely in itself
16. Number each steel shim together with each conical element.

Adjustment of Internal Buffer

17. Turn the internal buffer clockwise until it makes contact with the steel shim.
18. Turn the internal buffer anti-clockwise until it makes contact with the base casting.

This must be done in four full turns.

19. Turn the internal buffer 2 turn clockwise and check with a feeler gauge between the bottom flange on the conical element and the steel shim that the internal buffer(2), see fig 3, does not touch the steel shim.

20. After agreeing a groove of internal buffer(2) and a projection of top lock ring(4) and turn it to nearest thread hole-then secure with fixing bolt(6) and spring washer(5), see fig 1.

Mounting of Conical Elements to Foundation

21. Drill four mounting holes in the foundation for each conical element.
22. Fix the conical element and the steel shim to the foundation with four bolts.

NOTE! After completion of the above the buffer clearance must be checked, see items 17, 18, 19 and 20.

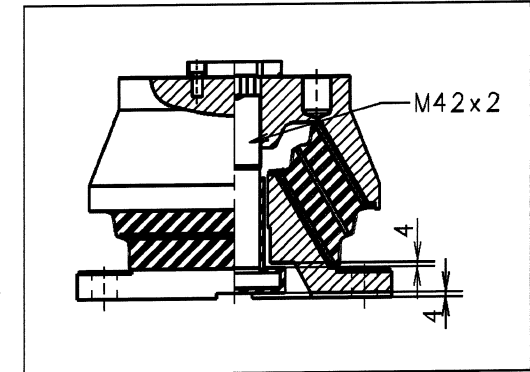


Fig 3. Internal Buffer

Supplement Drawing no.:					Projection:		Mass (kg):	Material / Blank:
					Licensor's Ident. no.:		Dist.:	Licensor's Material / Blank:
							A82	
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement		C.No
				*	*	Replaced by Ident. No.:		9
				*	*			8
				*	*			7
				*	*			6
				*	*			5
				*	*			4
				*	*			3
				*	*			2
				*	*			1
080604KHOKCSKCS					*	Changed note no.8		
050411GJHRYSRYS					*	YOUIL CONICAL MOUNTING		0
Similar Drawing No.:					Replacement of Ident. No.:			
Scale:	Size:	Type:	Page No.:			HYUNDAI		
NS.	A3	ALL TYPE	04 (04)			HEAVY INDUSTRIES CO. LTD.		
Info. No.:		Description:		Ident. No.:				
000000		INSTRUCTION FOR RESILIENT MOUNT		B93-012758-4				

Mounting and Adjustment Instructions for New Generating Sets (Method 2)

Preparations for Adjustment of Conical Elements

If the conical elements have not been mounted by the factory, they must be mounted on the prepared brackets on the base frame. In case they have been mounted by the factory, please start with item No.2

1. Fit the conical elements to the bracket of the suspended equipment by means of four bolts screwed into the tapped holes on the top casting(5), see fig 1.

A 25mm supporting steel shim, complete with tapped holes for three jacking bolts and mounting holes drilled according to conical base casting dimensions, is required.

2. Remove fixing bolts(6), spring washer(5) and top lock ring(4) from the conical element, see fig 1.

3. Position the supporting steel shim as per fig 2. and locate the conical element by means of dowel pins.

4. Position the three jacking bolts in the tapped holes in the supporting steel shim as per fig 2.

5. Position the jacking bolts with a through-going of minimum 10mm, see fig 2.

6. Lower the generating set until it rests completely on the foundation.

- Pos. 1 Base casting
Pos. 2 Internal buffer
Pos. 3 Top casting
Pos. 4 Top lock ring
Pos. 5 Spring washer
Pos. 6 Fixing bolt
Pos. 7 Tapped hole M14

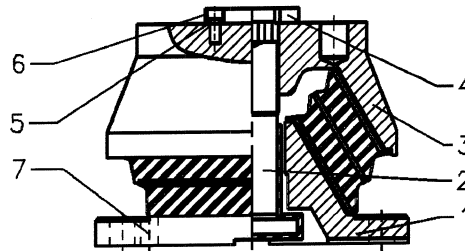


Fig 1. Conical element

Supplement Drawing no.:						Projection:		Mass (kg):		Material / Blank:		
						Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
								A82				
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement						C.No
				*	*	Replaced by Ident. No.:						9
				*	*							8
				*	*							7
				*	*							6
				*	*							5
				*	*							4
				*	*							3
				*	*							2
				*	*							1
080604KHOKCSKCS						* * Changed note no.9						0
050411GJHRYRSYS						* * YOU'L CONICAL MOUNTING						0
Similar Drawing No.:						Replacement of Ident. No.:						
Scale:	Size:	Type:	ALL TYPE			Page No.:			01 (04)			
NS.	A3											
Info. No.:						Description:						Ident. No.:
000000						INSTRUCTION FOR RESILIENT MOUNT						B93-012759-6

7. Check that all jacking bolts have full contact with the foundatain.
 8. Turn the internal buffer(2) to check that it can be moved freely,see fig 1.

If all internal buffers	Then
move freely	let conical element settle for 48 hours.
cannot be moved freely	turn the three jacking bolts in the supporting steel shim clockwise,or anti-clockwise to release the internal buffer.

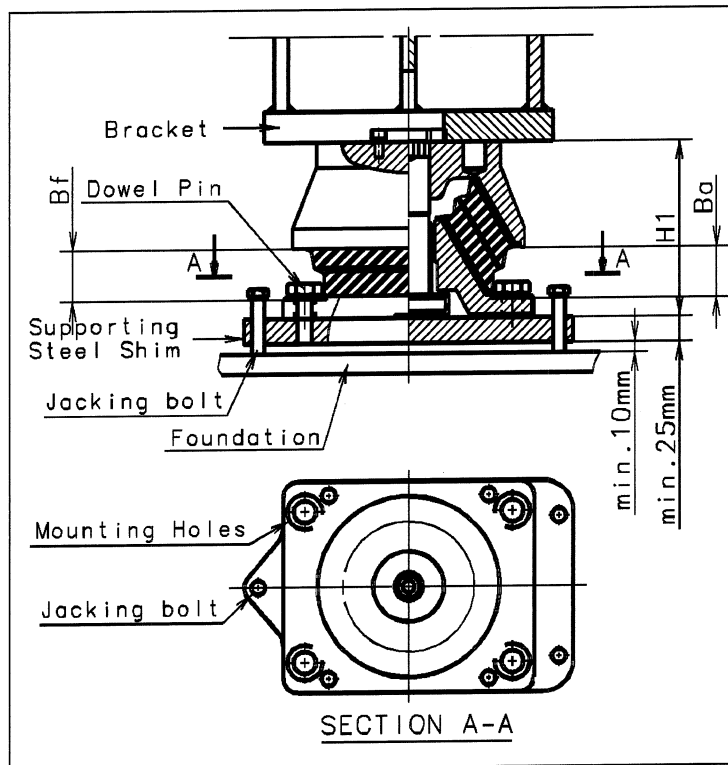


Fig 2.

Supplement Drawing no.:						Projection:	Mass (kg):	Material / Blank:
						Licensor's Ident. no.:	Dist.:	Licensor's Material / Blank:
						A82		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement		C.No
				*	*	Replaced by Ident. No.:		9
				*	*			8
				*	*			7
				*	*			6
				*	*			5
				*	*			4
				*	*			3
				*	*			2
				*	*			1
080604KHOKCSKCS						* * Changed note no.9		0
050411GJHRYRSYS						* * YOUIL CONICAL MOUNTING		
Similar Drawing No.:						Replacement of Ident. No.:		
Scale:	Size:	Type:	Page No.:					
NS.	A3	ALL TYPE	02 (04)					
Info. No.:						Ident. No.:		
000000						B93-012759-6		
Description:						INSTRUCTION FOR RESILIENT MOUNT		

Adjustment of Conical Elements after 48 Hours Settling

After the conical elements have been deflected under static load for 48 hours the load height(H1), see fig 2, should be measured and compared to the recommended load height.

9. The variation in laden height should not be exceed 2mm and should ideally be less to ensure that individual mountings are not overloaded.

If	Then
the difference exceeds 2mm.	Level the conical element by adjusting the jacking bolts - commencing with the conical element with the largest deviation.
the difference does not exceed 2mm.	The height of the steel shim can be measured.

Also the difference between Bf(f:forward direction) and Ba(a:afterward direction) should not be more than 0.6mm.

Measuring of Steel Shim

10. Measure the steel shim on several points to obtain the highest possible accuracy during preparation.

Fabricating Steel Shim

11. Make sure that the minimum height of the supporting steel shim is 25mm in order to secure the future replacement of the supporting steel shim.

Drill the mounting holes in the steel shim according to the conical base casting dimensions.

Supplement Drawing no.:					Projection:	Mass (kg):	Material / Blank:
					Licensor's Ident. no.:	Dist.:	Licensor's Material / Blank:
					A82		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	
				*	*	Replaced by Ident. No.:	
				*	*	9	
				*	*	8	
				*	*	7	
				*	*	6	
				*	*	5	
				*	*	4	
				*	*	3	
				*	*	2	
				*	*	1	
080604KHOKCSKCS					*	Changed note no.9	
050411GJHRYSRYS					*	YOUIL CONICAL MOUNTING	
Similar Drawing No.:					Replacement of Ident. No.:		
Scale:	Size:	Type:	Page No.:		HYUNDAI		
NS.	A3	ALL TYPE	03 (04)		HEAVY INDUSTRIES CO., LTD.		
Info. No.:	Description:		Ident. No.:				
000000	INSTRUCTION FOR RESILIENT MOUNT		B93-012759-6				

Mounting of Complete Steel Shim

12. Lift the generating set 1mm totally by means of three jacking bolts.
13. Position each complete steel shim.
14. Re-lower the generating set by means of three jacking bolts until it rests completely in itself.

Adjustment of Internal Buffer

15. Turn the internal buffer clockwise until it makes contact with the supporting steel shim.
16. Turn the internal buffer anti-clockwise until it makes contact with the base casting.

This must be done in four full turns.

17. Turn the internal buffer 2 turn clockwise and check with a feeler gauge between the bottom flange on the conical element and the supporting steel shim that the internal buffer(2), see fig 1, does not touch the supporting steel shim.

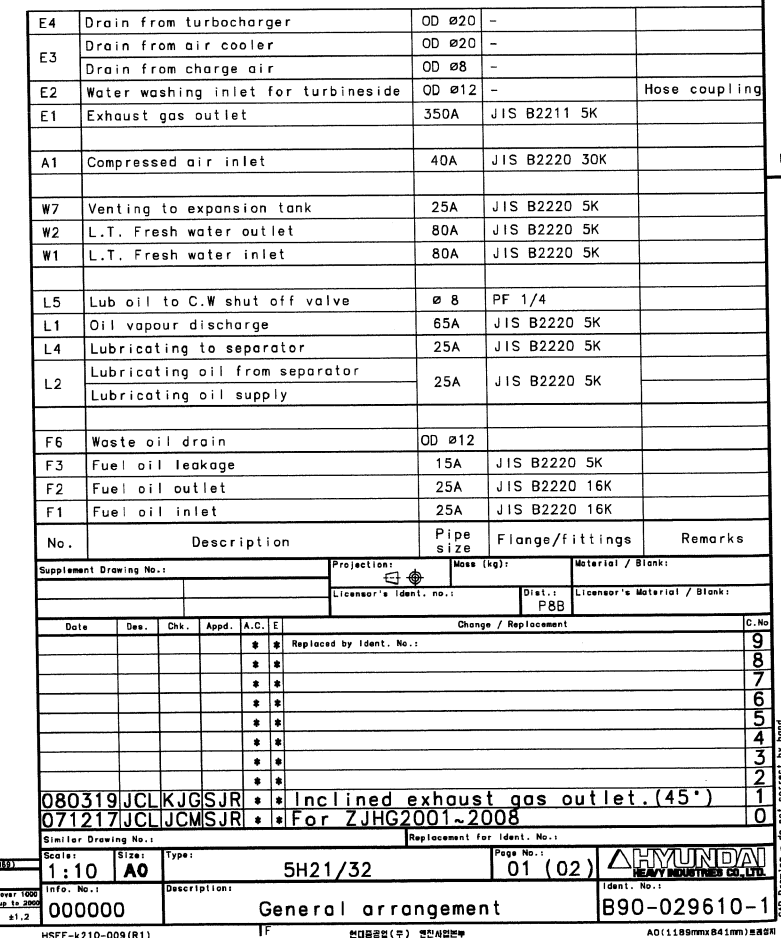
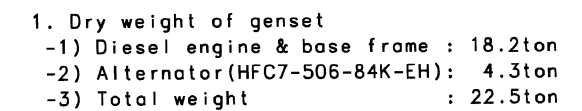
18. After agreeing a groove of internal buffer(2) and a projection of top lock ring(4) and turn it to nearest thread hole-then secure with fixing bolt(6) and spring washer(5), see fig 1.

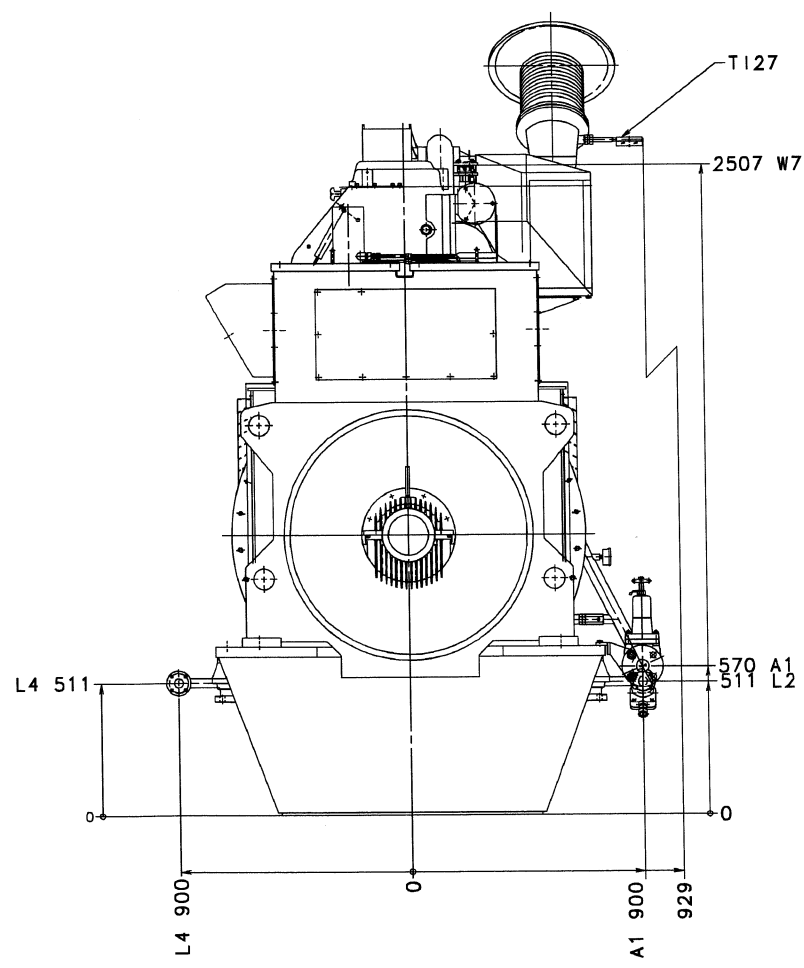
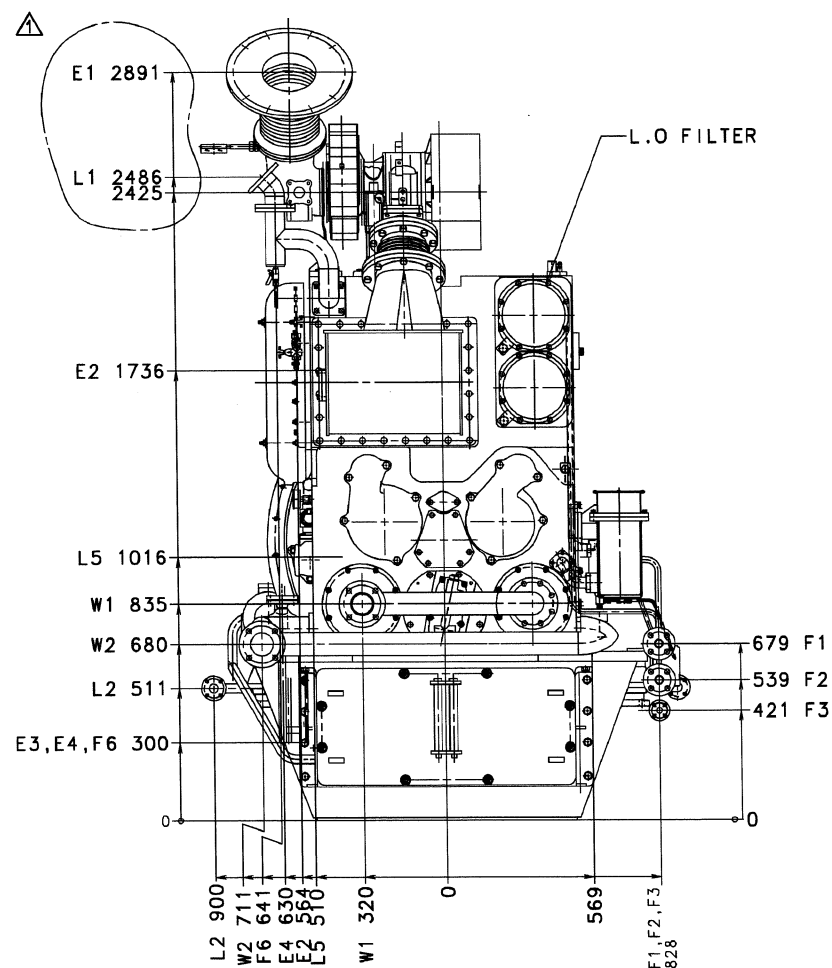
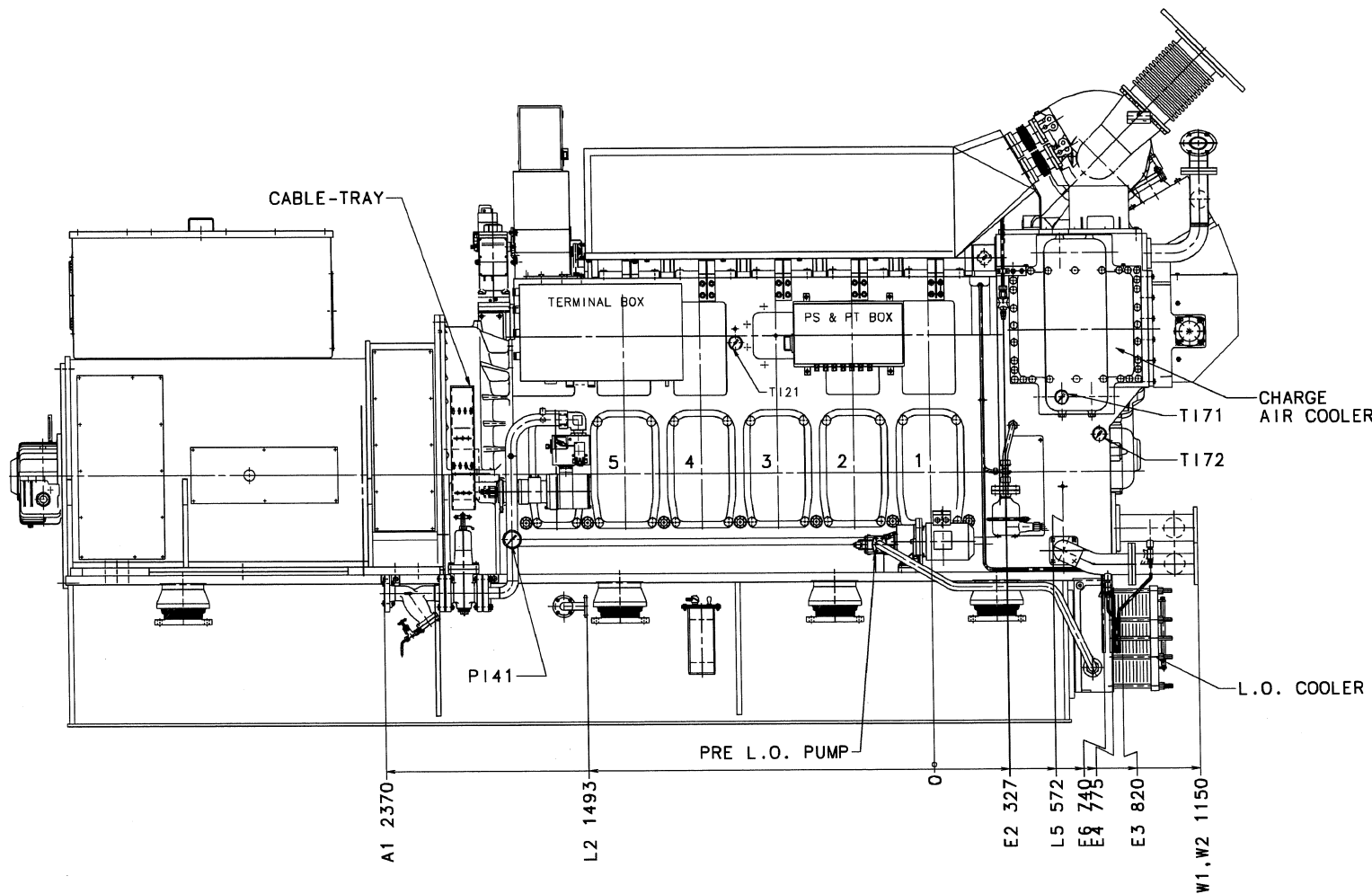
Mounting of Conical Elements to Foundation

19. Remove the dowel pins.
20. Drill four mounting holes in the foundation for each conical element.
21. Fix the conical element and the supporting steel steel shim/steel shim to the foundation with four bolts.
22. Weld the lowest steel shim to the foundatain.

NOTE! After completion of the above, the buffer clearance must be checked, see items 15, 16, 17 and 18.

Supplement Drawing no.:					Projection: 		Mass (kg):		Material / Blank:			
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:			
							A82					
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					C.No	
				*	*	Replaced by Ident. No.:					9	
				*	*						8	
				*	*						7	
				*	*						6	
				*	*						5	
				*	*						4	
				*	*						3	
				*	*						2	
				*	*						1	
				*	*						0	
080604KHOKCSKCS					*	*	Changed note no.9					
050411GJHRYSRYS					*	*	YOUIL CONICAL MOUNTING					
Similar Drawing No.:					Replacement of Ident. No.:							
Scale:	Size:	Type:	Page No.:			HYUNDAI HEAVY INDUSTRIES CO., LTD.						
NS.	A3	ALL TYPE	04 (04)									
Info. No.:					Description:					Ident. No.:		
000000					INSTRUCTION FOR RESILIENT MOUNT					B93-012759-6		



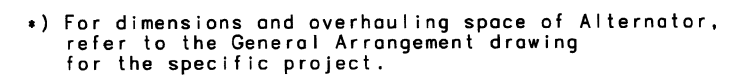
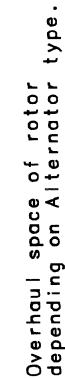


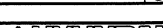
This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
0.025	0.05	0.1	0.2	0.4	0.6	1.0	1.6	2.5	4.0	6.3	10.0	16.0

Surface finish	0.1	0.2	0.4	0.6	1.0	1.6	2.5	4.0	6.3	10.0	16.0	25.0
0.1	0.2	0.4	0.6	1.0	1.6	2.5	4.0	6.3	10.0	16.0	25.0	40.0

Supplement Drawing No.:		Projection:	Mass (kg):	Material / Blank:
Licensor's Ident. No.:		Dial.:	Licensor's Material / Blank:	
		P8B		
Date	Des.	Chk.	Appd.	A.C.
Change / Replacement				C.No
Replaced by Ident. No.:				9
				8
				7
				6
				5
				4
				3
				2
				1
				0
080319JCLKJGSJR * Inclined exhaust outlet.(45°)				
071218JCLJCMSJR * For ZJHG2001~2008				
Similar Drawing No.:				
Replacement for Ident. No.:				
Scale:	Size:	Type:	Page No.:	
1:10	A0	5H21/32	02 (02)	
Description:		Ident. No.:		
000000		B90-029610-1		
HSEF-K210-009(R1)				



Supplement Drawing No.:				Projection:		Moss (sg):		Material / Blanks:		
				Licensor's Ident. no.:		Dist.:		Licensor's Material / Blanks:		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No
						*	*	Replaced by Ident. No.:		9
						*	*			8
						*	*			7
						*	*			6
						*	*			5
						*	*			4
						*	*			3
						*	*			2
070710UMJKSWKSW						*	*	Changed dimension based on crankshaft		1
070416JSOKSRJR						*	*			0
Similar Drawing No.:					Replacement for Ident. No.:					
Scale:	Size:	Type:			Page No.:		IDENT. NO.			
1:10	A0	5,6H21/32			01 (02)					
Info. No.:		Description:					Ident. No.:			
000000		OVERHAUL DIMENSION OF MAIN COMPONENTS					B90-023817-1			

Technical drawing of the HPR3000 TPS48 engine assembly, showing a side view and detailed views of the cylinder unit, piston, cylinder liner, and cylinder head.

Dimensions (mm):

- Overall height: 1158
- Height from crankshaft centerline to top of cylinder head: 1569
- Height from crankshaft centerline to top of piston: 1092
- Height from crankshaft centerline to top of cylinder liner: 1037
- Height from crankshaft centerline to top of cylinder unit: 1000
- Height from crankshaft centerline to top of piston (detailed view): 54
- Height from crankshaft centerline to top of cylinder liner (detailed view): 58.3
- Height from crankshaft centerline to top of cylinder head (detailed view): 67.5
- Height from crankshaft centerline to top of cylinder unit (detailed view): 67.5
- Height from crankshaft centerline to top of piston (detailed view): 54
- Height from crankshaft centerline to top of cylinder liner (detailed view): 58.3
- Height from crankshaft centerline to top of cylinder head (detailed view): 67.5
- Height from crankshaft centerline to top of cylinder unit (detailed view): 67.5

Labels:

- Cylinder unit 2777
- Piston 2327
- Cylinder liner 2293
- Cylinder head 2092
- HPR3000 TPS48
- 0 of crankshaft

Overhauling at the service side for H21/32

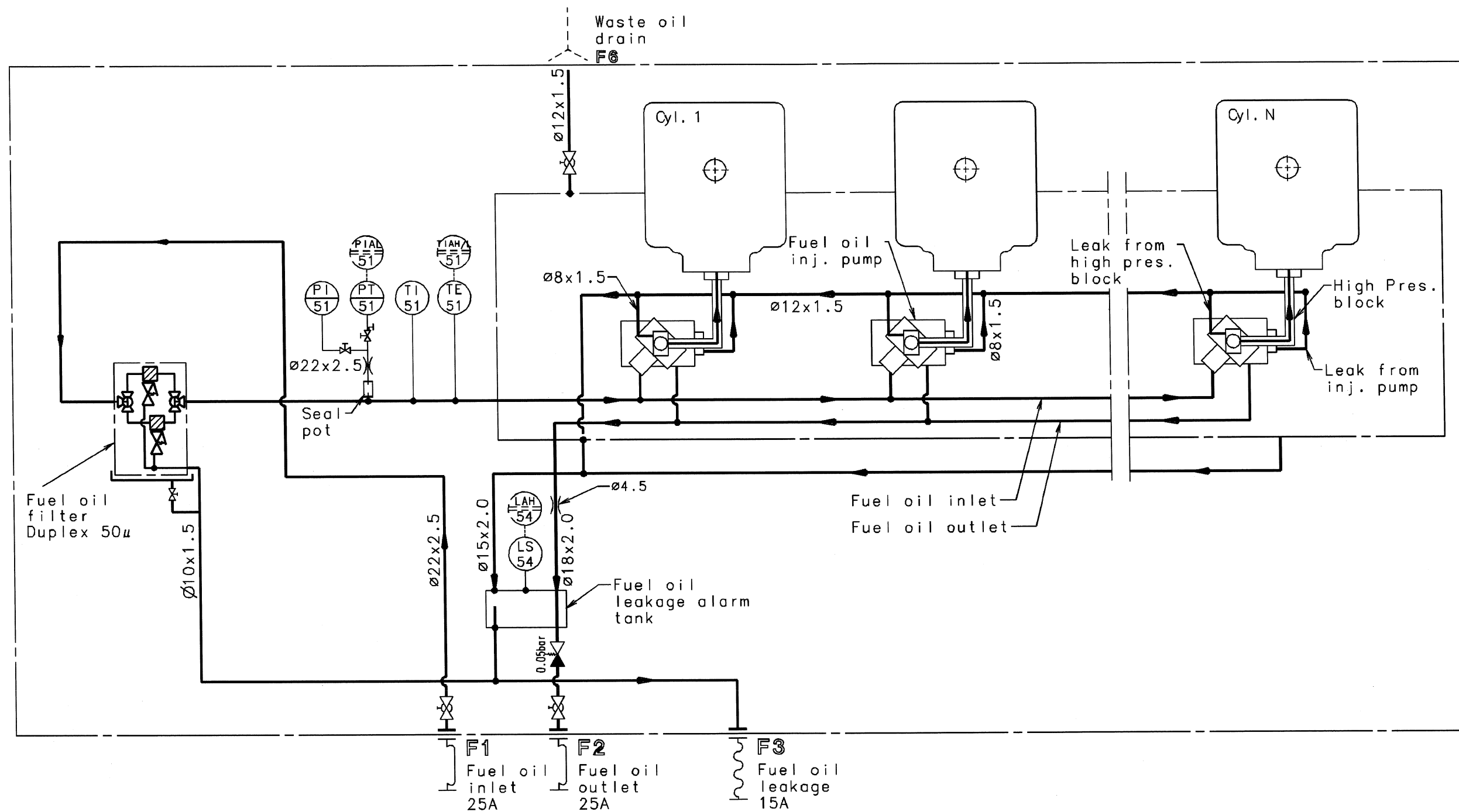
The diagrams illustrate the assembly sequence for overhauling the service side of an H21/32 engine. Each diagram includes dimensions and a right-pointing arrow indicating the direction of assembly.

- Cylinder unit:** Dimensions include 135, 918.5, 50, 2551, 607, 840, and t of crankshaft.
- Cylinder liner:** Dimensions include 649, 50, 2146, 607, 840, and t of crankshaft.
- Cylinder head:** Dimensions include 135, 338, 50, 1958, 607, 840, and t of crankshaft.
- Piston:** Dimensions include 708, 50, 318, 1916, 840, and t of crankshaft.

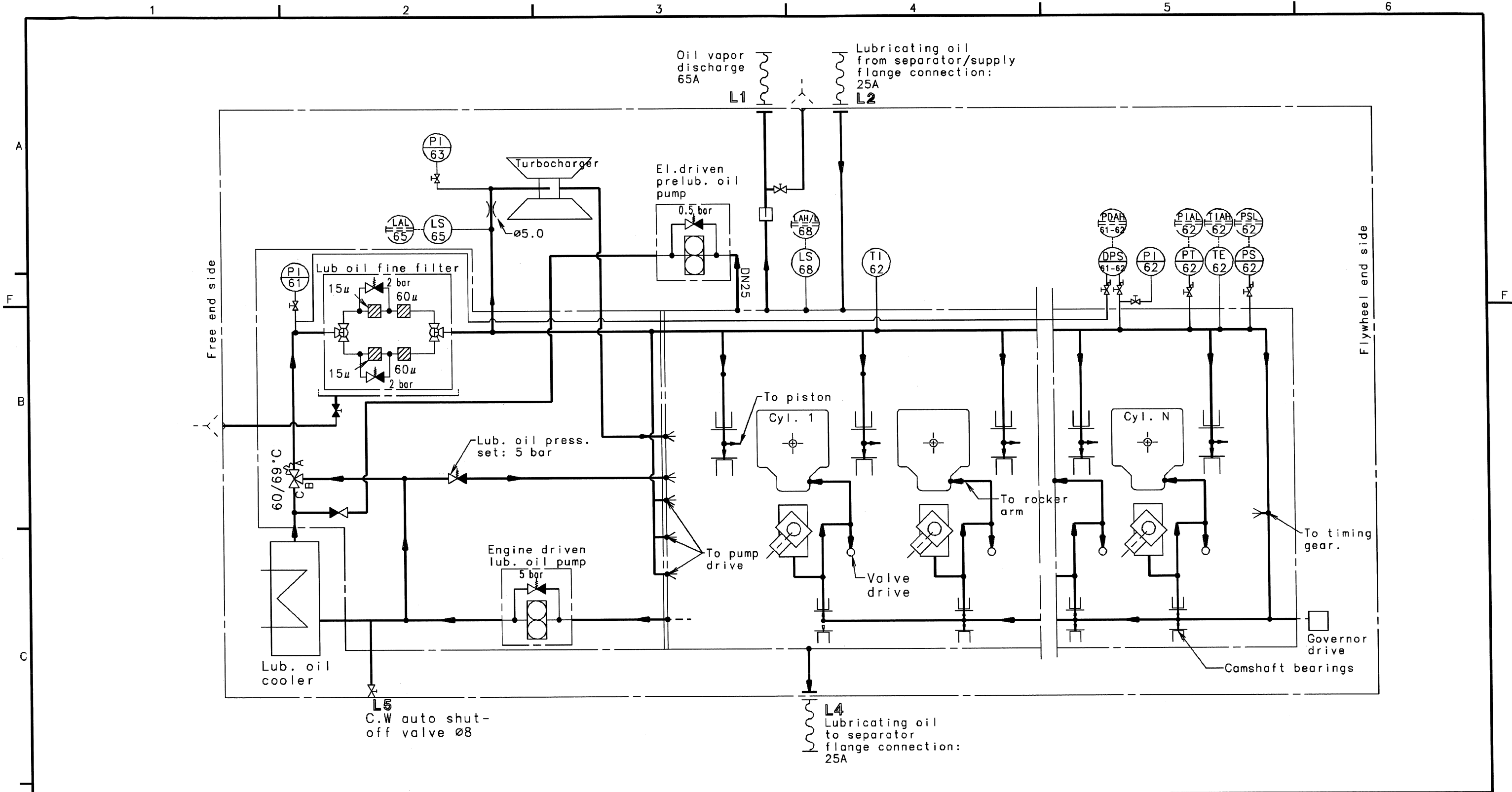
Supplement Drawing No.:					Projection:		Mass (kg):		Material / Blank:		
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					C.No
					*	* Replaced by Ident. No.:					9
					*						8
					*						7
					*						6
					*						5
					*						4
					*						3
					*						2
					*						1
070710UMJKSWKSW					*	* Changed dimension based on crankshaft					1
070416JSOKSRSJR					*						0
Similar Drawing No.:						Replacement for Ident. No.:					
Scale:	Size:	Type:				Page No.:					
1:10	A0	5,6H21/32				02 (02)					
Info. No.:		Description:					Ident. No.:				
000000		OVERHAUL DIMENSION OF MAIN COMPONENTS					B90-023817-1				

Supplement Drawing No.:					Projection:		Mass (kg):		Material / Blank:		
											
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
					1631472-4.1						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					C.N.
				*	*	Replaced by Ident. No.:					9
				*	*						8
				*	*						7
				*	*						6
				*	*						5
				*	*						4
030212	DYJ	DYJ	SMH	*	*	Added No.7.11					3
000228	JJO	JJO	SMH	*	*	Mod. text					2
970902	KHG	KHG	SMH	*	*	Mod. to 7.8,8					1
931212	SMH	SMH	LCS	*	*						0
Similar Drawing No.:						Replacement of Ident. No.:					
Scale:		Size:		Type:		Page No.:					
-		A2		-		01 (01)					
Info. No.:		Description:				Ident. No.:					
372356		Basic symbols for piping diagram				B12-103680-					

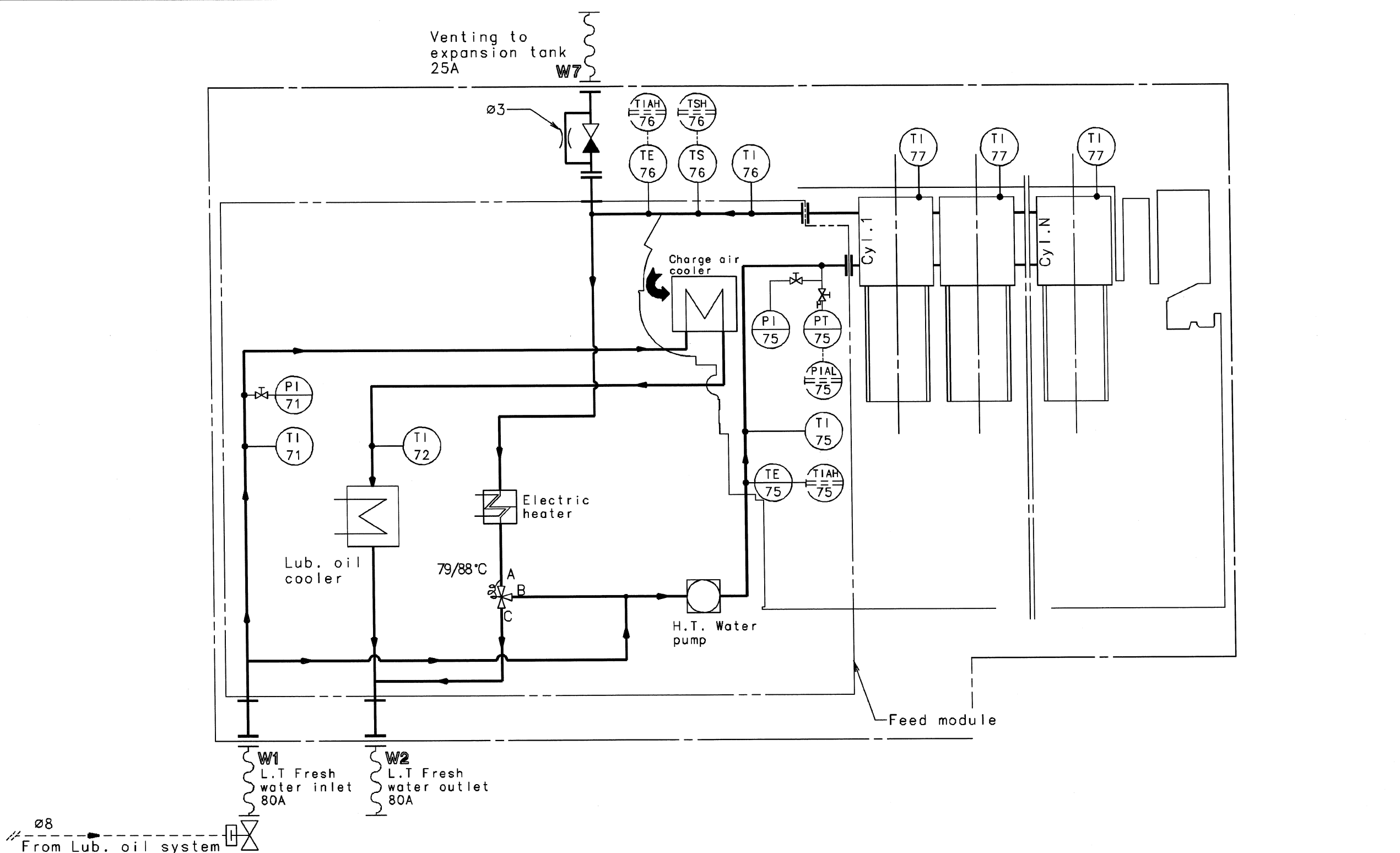
Tolerances for dimensions without tolerance indication (ISO 2768-1989)							
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.							
Nom. measurement	0,5	over 6	over 30	over 120	over 315	over 1000	
Permissible deviations	up to 6	up to 30	up to 120	up to 315	up to 1000	up to 1000	
Medium section	+0,1	+0,2	+0,3	+0,5	+0,8	+1,2	



1. Specification for piping system									2. Instruments for pressure gauge & thermometer							Supplement Drawing No.:		Projections:		Mass (kg):		Material / Blank:													
System	Temp. °C	Nom. Dia.	Thick-ness	Mat'l	Test Press.	Pipe con. Type	Pipe con. Mat'l	Remark	No.	Tag no.	Description	Q'ty	Range	Operating range	Remark	Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:															
High pressure block H.F.O.	150°C	ø16	6.0	SQM440	2300	Flange type joint	Forged steel		01	PI51	Fuel oil inlet(H.F.O.)	1	0-16bar	7~10bar	PF1/4	-		P8B		-															
Fuel oil in/out H.F.O.	150°C	ø22	2.5	DIN 1630 St37.4	15	Sleeve type joint	S45C-N	Painted after pickling								Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No.												
		ø18	2.0						01	TI51	Fuel oil Inlet(H.F.O.)	1	0-200°C		PF1/2						*	*	Replaced by Ident. No.:	9											
						JIS B2220 slip on	JIS G3101 SS400														*	*		8											
																					*	*		7											
Fuel oil leaked	-	ø15	2.0	DIN 1630 St37.4	-	Bited type joint	S45C-N	Painted after pickling													*	*		6											
																				*	*		5												
																				*	*		4												
																				*	*		3												
																				*	*		2												
																				*	*		1												
																				*	*		0												
071218JCLJCMSJR																*		*		For ZJHG2001~2008															
Similar Drawing No.:																-		Replacement of Ident. No.:																	
This drawing, together with its supplements, is the property of HH-EEMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HH-EEMD products, according to contract or other written agreement hereon with HH-EEMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HH-EEMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient. 이 도면은 본회제품의 제작이나 보수용에 한하여 이도만 가능하며 무단으로 제3자에게 제공하거나, 이도만제공한 부품품 목적을 제3자에게 판매하는 것은 엄격히 금지됩니다.																Standard for surface roughness The basic symbols and class numbers are in accordance with ISO 1302-1978.										Tolerances for dimensions without tolerance indication(ISO 2768-1989) This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.									
																Class No.										N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
R max. µg/mm										0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50	Per-missible deviations		up to 6	up to 30	up to 120	up to 315	up to 1000	up to 2000						
										Medium series										±0.1	±0.2	±0.3	±0.5	±0.8	±1.2										
Scale: -																Size: A2		Type: 5H21/32		Page No.: 01 (01)		Info. No.:		Description: Fuel oil system		Ident. No.: B92-029611-3									



1. Specification for piping system										1. Instruments for pressure gauge & thermometer										Supplement Drawing No.:						Projection: 		Mass (Kg):		Material / Blank:																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
System	Press. kg/cm²	Temp. °C	Nom. Dia.	Thick-ness	Mat'l	Test press.	Pipe con. type	Pipe con. mat'l	Remark	No.	Tag no.		Q'TY	Range	Operating range	Remark																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					</



on for piping system								2. Instruments for pressure gauge & thermometer								Supplement Drawing No.:						Projection: 		Mass (kg):		Material:																											
emp. °C	Nom. Dia.	Thick-ness	Mat'l	Test press.	Pipe con. type	Pipe con. mat'l	Remark	No.	Tag no.	Description	Q'TY	Range	Operating range	Remark							Licensor's Ident. no.:		Dist.: P8B		Licensor																												
-	-	-	-	-	-	-	-	01	PI71	L.t. f.w. engine inlet	1	0-6bar	1.5-4.5bar	PF1/4																																							
-	-	-	-	-	-	-	-	02	PI75	H.t. f.w. engine inlet	1	0-6bar	1.5-4.5bar	PF1/4																																							
-	-	-	-	-	-	-	-																																														
-	-	-	-	-	-	-	-	01	TI71	L.t. f.w. a/c inlet	1	0-120°C		PF1/2																																							
-	80A	5.5	JIS G3454 STPG370-E	-	JIS B2220 slip on	JIS G3101 SS400	Painted after pickling	02	TI72	L.t. f.w. a/c outlet	1	0-120°C		PF1/2																																							
								03	TI75	H.t. f.w. engine inlet	1	0-120°C		PF1/2																																							
								04	TI76	H.t. f.w. engine outlet	1	0-120°C		PF1/2																																							
																071218JCLJCMSJR																																					
																Similar Drawing No.:						Replacement of Ident. No.:																															
with its supplements, is the property of HHI-EMD and subject to copyright protection. Not at the disposal of the recipient solely for his own use, and only for the manufacture, of HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD either wholly or partly, be copied, reproduced, made public or in any other way made party without the written consent to this effect from HHI-EMD. The material must not be ver to any third party, neither direct nor by succession to the rights of the recipient. 본사와 소련장이 이도본과 375970에 영도, 복사, 인쇄, 복사, 이도본에 복사 부본을 제작하여 제3자에게 판매하는 것은 許해받지않는다.								Standard for surface roughness								Tolerances for dimensions without tolerance indication(ISO 2768-1988)								Scale:		Size: A2		Type:		9H21/32		901 (01)		4																			
								The basic symbols and class numbers are in accordance with ISO 1302-1978.								This standard states the permissible deviations for dimension without direct tolerance indication on metallic components manufactured by machining.																																					
								Class No.								N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	Nom.measurement		0,5		over 6		over 30		over 120		over 315		over 1000													
								R max.								0,025		0,05		0,1		0,2		0,4		0,8		1,6		3,2		6,3		12,5		25		50		Per-missible deviations		up to 6		up to 30		up to 120		up to 315		up to 1000		up to 2000	
								vglus, µm								0,025		0,05		0,1		0,2		0,4		0,8		1,6		3,2		6,3		12,5		25		50		Medium series		±0,1		±0,2		±0,3		±0,5		±0,8		±1,2	
																								375970																													

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use as original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to his effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

Conn. no.	Description	Drawing no.	Part no.	Q'ty/eng.	Connection flange
A1	Starting air inlet	B12-122872-3.5	B19-102554-7	1	JIS B2220 30K-40
F1,F2	F.O. inlet/outlet	B12-122870-0.4	-	2	JIS B2220 16K-25
F3	Waste oil outlet	B12-122871-1.9	B19-102535-8	1	JIS B2220 5K-15
L1	Oil vapor discharge	B12-122871-1.9	B19-102541-6	1	JIS B2220 5K-65
L2,L4	L.O supply & from/to separator	B12-122871-1.9	B19-102537-1	2	JIS B2220 5K-25
W1/W2	L.T. fresh water in/outlet	B12-130471-9.6	B19-127775-2	2	JIS B2220 5K-80
W7	Venting to expansion tank	B12-122871-1.9	B19-102537-1	1	JIS B2220 5K-25
W1/W2	Guard	B93-015145-7.1	B99-007144-0	2	80A

Specification

- Flexible hose to be type approved according to the demands of the classification society.
신축관은 선급이 정하는 규정에 따라 형식승인을 득 할것.
- For quality instruction see draw. no. B14-122897-3.1.
품질사항서는 도면번호 B14-122897-3.1을 볼것.
- For installation instruction see draw. no. B11-122888-0.7.
설치 시방서는 도면번호 B11-122888-0.7을 볼것.

Standard for surface roughness (ISO 1302-1978)		Supplement Dwg no.:		Projection: 		Mass (kg):		Material / Blank:																																																																																												
Tolerances for dimensions without tolerance indication (ISO 2768-1989)				Licensor's Ident. no.:		Dist.: P82		Licensor's Material / Blank:																																																																																												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12																																																																																								
Rmax. (µm)	0.025	0.05	0.1	0.2	0.4	0.6	1.0	1.6	2.5	4.0	6.3	10																																																																																								
Permissible deviation (mm)	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2																																																																																														
<table border="1"> <thead> <tr> <th>Date</th> <th>Des.</th> <th>Chk.</th> <th>Appd.</th> <th>A.C.</th> <th>E</th> <th>Change / Replacement</th> <th>C.No</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td>*</td> <td>*</td> <td>Replaced by Ident. No.:</td> <td>9</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>*</td> <td>*</td> <td></td> <td>8</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>*</td> <td>*</td> <td></td> <td>7</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>*</td> <td>*</td> <td></td> <td>6</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>*</td> <td>*</td> <td></td> <td>5</td> </tr> <tr> <td>080215</td> <td>JCL</td> <td>KJG</td> <td>SJR</td> <td>*</td> <td>*</td> <td>Revised drawing no. (F1,F2)</td> <td>4</td> </tr> <tr> <td>070906</td> <td>JCL</td> <td>JCMS</td> <td>SJR</td> <td>*</td> <td>*</td> <td>Corrected text.</td> <td>3</td> </tr> <tr> <td>070614</td> <td>DYJ</td> <td>JCMS</td> <td>SJR</td> <td>*</td> <td>*</td> <td>Revised drawing no.</td> <td>2</td> </tr> <tr> <td>070129</td> <td>DYJ</td> <td>JCMS</td> <td>SJR</td> <td>*</td> <td>*</td> <td>Revised drawing no.</td> <td>1</td> </tr> <tr> <td>051128</td> <td>DYJ</td> <td>JCMS</td> <td>SJR</td> <td>*</td> <td>*</td> <td></td> <td>0</td> </tr> </tbody> </table>													Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No					*	*	Replaced by Ident. No.:	9					*	*		8					*	*		7					*	*		6					*	*		5	080215	JCL	KJG	SJR	*	*	Revised drawing no. (F1,F2)	4	070906	JCL	JCMS	SJR	*	*	Corrected text.	3	070614	DYJ	JCMS	SJR	*	*	Revised drawing no.	2	070129	DYJ	JCMS	SJR	*	*	Revised drawing no.	1	051128	DYJ	JCMS	SJR	*	*		0
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No																																																																																													
				*	*	Replaced by Ident. No.:	9																																																																																													
				*	*		8																																																																																													
				*	*		7																																																																																													
				*	*		6																																																																																													
				*	*		5																																																																																													
080215	JCL	KJG	SJR	*	*	Revised drawing no. (F1,F2)	4																																																																																													
070906	JCL	JCMS	SJR	*	*	Corrected text.	3																																																																																													
070614	DYJ	JCMS	SJR	*	*	Revised drawing no.	2																																																																																													
070129	DYJ	JCMS	SJR	*	*	Revised drawing no.	1																																																																																													
051128	DYJ	JCMS	SJR	*	*		0																																																																																													
Similar Drawing No.:						Replacement of Ident. No.:																																																																																														
Scale: 1:1		Size: A4		Type: -		Page No.: 01 (01)																																																																																														
Info. No.: 372358				Description: List for flexible hose connection				Ident. No.: B94-015157-6																																																																																												

INSTALLATION PROCEDURE FOR EXHAUST GAS BELLOW(Fig.2)

배기가스용 신축관의 설치시범서(그림 2)

NOTE : The exhaust pipe must not be exerted any force against gas outlet on the engine.

기관실의 배기관은 어떠한경우에도 엔진상부의 가스출구쪽으로 모든 물리적인힘이 작용되어 영향을 주지 않아야 한다.

The sturdy fixed-point support must be provided for the bellows on the turbocharger.

과급기를 신축관의 고정지지대는 매우견고하게 고정되어야 한다.

It should be positioned, immediately above the bellows in order to prevent the transmission of forces, resulting from the weight, thermal expansion or lateral displacement of the exhaust piping, to the turbocharger.

고정지지대의 위치는 기관실 배관의 무게, 축방향변위(팽창)등의 물리적인 변동이 과급기에 전달되는것을 피하기 위하여는 신축관의 바로위에 설치되어야 한다.

No axial, lateral or angular deflection of the bellow is allowed.

INSTALLATION PROCEDURE

설치를위한 시범서

1.The generating set(or engine)should be installed in its final position before any external pipes are connected.

모든 배관들의 연결은 발전기세트(엔진)가 최종으로 설치완료후에 연결할것.

2.Remove the counter flange from the engine connection, if fitted.

엔진측 연결용 배관에 기관실연결용 후렌치가 부착되었으면 제거할것.

3.Fasten the counter flange temporarily to the outlet side of the bellows.

신축관의 출구측에 상대후렌치를 임시로 설치할것.

For the correct orientation of the bellows(flow direction)

see the dimensional drawing.

정확한 가스의 흐름방향은 상세도면을 참조할것.

4.Fasten the bellow to the engine temporarily.

신축관을 엔진에 임시로 설치할것.

5.Align the external pipe to the counter flange.

기관실을 배관과 후렌치를 일직선으로 정렬시킬것.

No axial, lateral or angular deflection of the bellow is allowed.

신축관은 횡, 축, 비틀림 변형이 없도록.

Anchor the external pipe to the steel structure within 1m from flanges.

기관실 배관은 철구조물에 후렌치와 1m이내에 고정할것.

Observe that the pipe clamping with bracket must be very rigid

in order to prevent vibration and movement of the exhaust gas pipe.

배기관의 이동 및 진동을 방지하기위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

Most problems with bursting and vibrations originate from poor clamping and support.

파열 및 진동들 대부분의 문제점들은 부실한 고정 및 지지에서 발생된다.

Especially the support in the axial direction must be rigid.

특히 축방향의 지지대는 매우 고정되어야 한다.

6.Put some temporary protection cover between the flange in order to prevent debris from falling into the turbocharger.

과급기 내부에 이물질이 안입되는것을 방지하기위한 보호를 커버를 임시로 설치할것.

7.Tack weld the counter flange to the external pipe.

기관실 배관에 후렌치를 가 용접할것.

8.Remove the bellow and weld the flange finally to the external pipe.

신축관을 제거하고 기관실 배관에 후렌치를 완전히 용접할것.

9.Remove the protection cover.

Place the bellows with gaskets between the flanges.

후렌치와 가스켓 사이의 보호용 커버를 제거할것.

후렌치 사이에 가스켓과 볼로우즈를 조립할것.

10.Lubricate the threads of the connection screw with heat resistant grease and tighten first until finger tight.

Finally tighten the screw in a diagonal sequence.

연결용 볼트의 나사부에 내열성 그리스를 바르고 순으로 조인후 대각순으로 완전히 조일것.

11.Remove the guide bar between the flanges of the bellow.

신축관의 후렌치 사이에는 지지대를 제거할것.

INSTALLATION PROCEDURE FOR LOOP EXPANSION PIPE(Fig.1)

연료유용 신축관의 설치시범서(그림1)

NOTE : The internal LENGTH 'L' between the flanges must be in accordance with actual drawing of the loop expansion pipe by used the jig.

후렌치사이의 길이 'L'은 JIG를 사용하여 실제 신축관 도면의 길이를 따를것.

Length between engines flange and ship's flange must coincide within $\pm 2mm$.

엔진후렌치와 선박후렌치사이 거리는 $\pm 2mm$ 범위 이내에 들어야 한다.

The eccentric axis of flanges must coincide within $\pm 1mm$

불편치와 불편치 주축의 편심은 $\pm 1mm$ 범위내에 있어야 한다.

Please observe at normal operating condition that not heavy vibration occurs in expansion loop(amplitude must not exceed 0.5mm).

정상 운전 상태에서 루프의 큰진동이 발생하지 않는지 관찰한다. (진폭은 0.5mm를 초과 하지 않아야 한다.)

Please observe at start/stop operating condition that not heavy vibration occurs in expansion loop(amplitude must not exceed 5.0mm).

시동/정지 운전 상태에서 루프의 큰진동이 발생하지 않는지 관찰한다. (진폭은 5.0mm를 초과 하지 않아야 한다.)

The flange is fitted with 4 bolts, and can be installed in any of the 4 possible direction.

후렌치 볼트는 4개의 볼트로 고정되며, 4방향 모두 설치 가능하다.

If necessary 4 extra bolt-holes may be made in flanges of loop expansion joint(min. 10mm from existing holes).

만약 신축관의 방향 전환을 위해 후렌치의 볼트구멍을 추가 가공시에는 기존의 구멍과 최소 10mm이상 떨어져야 한다.

INSTALLATION PROCEDURE FOR COOLING WATER,LUB OIL,MIST GAS FLEXIBLE HOSE(Fig.2)

냉각수, 윤활유, 윤활유기화가스용 신축관의 설치시범서(그림2)

Note : The internal LENGTH 'L' between the flanges must be in accordance with actual drawing of the hose by used the jig.

후렌치사이의 길이 'L'은 JIG를 사용하여 실제 신축관 도면의 길이를 따를것.

Length between engines flange and ship's flange must coincide within $\pm 5mm$.

엔진후렌치와 선박 후렌치사이 거리의 공차는 $\pm 5mm$ 범위내에 있어야 한다.

The eccentric axis of flanges must coincide within $\pm 1mm$.

후렌치와 후렌치 주축 편심은 $\pm 1mm$ 범위 이내에 들어야 한다.

INSTALLATION PROCEDURE FOR COMPENSATOR(Fig.3, Fig.4)

신축관의 설치시범서(그림3, 그림4)

NOTE : The internal LENGTH 'L' between the flanges must be in accordance with actual drawing of the hose by used the JIG.

후렌치사이의 길이 'L'은 JIG를 사용하여 실제 신축관 도면의 길이를 따를것.

Length between engines flange and ship's flange must coincide within $L \pm 2mm$.

엔진 후렌치와 선박 후렌치사이 거리는 $L \pm 2mm$ 범위 내에 들어야 한다.

The eccentric axis of flanges must coincide within $\pm 1mm$.

후렌치와 후렌치 주축사이의 편심은 $\pm 1mm$ 범위내에 있어야 한다.

The expansion joint, compensator must be mounted without any twist.

신축관은 설치시 어떠한 위틀림도 없어야 한다.

The external connection to the expansion joint, compensator has to be rigidly fixed.

신축관 설치시 기관실 배관은 rigid하게 고정할 것.

Abrasion from adjacent structures, moving part or other hoses must be avoided.

신축관 보호를 위해 주변의 어떠한 구조물과도 간섭이 있어서는 안 된다.

The expansion joint, compensator must be mounted visible above floor level.

신축관은 잘 보일수 있도록 바닥위에 설치되어야 한다.

In case of need guard must be installed before install compensator.

신축관 보호용 guard는 필요 설치시 방진관 조립전에 가설할 후 신축관 설치후 제거한다.

INSTALLATION PROCEDURE

설치를위한 시범서

1.The generating set(or engine)should be installed in its final position before any external pipes are connected.

모든 배관들의 연결은 발전기세트(엔진)가 최종으로 설치완료후에 연결할것.

2.Remove the counter flange from the engine connection, if fitted.

엔진측 연결용 배관에 기관실연결용 후렌치가 부착되었으면 제거할것.

3.Fasten the fixed flange of the jig to the engine side a gasket(1.5t)

between the flanges(jig should be ready by shipyard).

엔진측 후렌치에 가스켓(1.5T)을 삽입후 jig를 부착할것9(jig는 조선소가 준비한다.)

4.Lubricate the threads of the connection screw with grease and tighten first until finger tight.

Finally tighten the screw in a diagonal sequence using a socket wrench.

연결용 볼트의 나사부에 그리스를 바르고 순으로 조인후 대각순으로 완전히 조일것.

5.Connect the free end of the jig to the external piping.

기관실측의 배관에 jig의 끝단을 연결할것.

6.Align the external pipe to the flange of the jig.

기관실을 배관과 후렌치를 일직선으로 정렬시킬것.

7.Anchor the external pipe to the steel structure with fixed support close to the flange.

기관실 배관은 고정용 지지대를 사용하여 철구조물에 후렌치와 가까운곳에 고정할것.

Observe that the pipe clamping with bracket must be very rigid

in order to prevent vibration and movement of the external pipe.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주의할것.

Most problems with bursting and vibrations originate from poor clamping and support.

파열 및 진동들 대부분의 문제점들은 부실한 고정 및 지지에서 발생된다.

8.Tag weld the counter flange to the external pipe.

기관실 배관에 후렌치를 가 용접할것.

9.Remove the jig and weld the flange finally to the external pipe.

- the welded part should be grinded and the projecting part should be removed after weld.(Refer fig.4)

기관실 배관을 분리하여 후렌치를 완전히 용접할 것. -벤드시 용접부분을 그리안딩하여 돌출부 제거(그림4참조)

10.Fasten the external pipe must be in line on the connection side and then fixed.

기관실 배관을 설치하여 일직선으로 정렬한후 고정할 것.

11.Remove the jig and gasket between external pipe and the engine side pipe.

기관실 배관과 엔진측 파이프 사이의 jig와 가스켓들을 제거할 것.

12.Connect the compensator both the external pipe and the engine pipe.

Axial, lateral or angular deflection of the compensator is allowed within allowable tolerance.

신축관을 기관실 배관과 엔진측 배관에 연결할 것.

신축관은 횡, 축, 비틀림 변형은 허용 공차내의 범위를 유지하여야 한다.

13.The compensator must be protection from external mechanical damage.

There must be enough space around the compensator connection for regular supervision and maintenance.

신축관 및 연결부는 외부의 물리적인 충격으로부터 손상에 보호되어야 한다.

또한 정기점검과 보수유지를 위하여는 신축관주위에는 충분한 공간을 확보할것

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct

Grinding the welded part and projecting part

용접부 및 돌출부 그리안딩작업

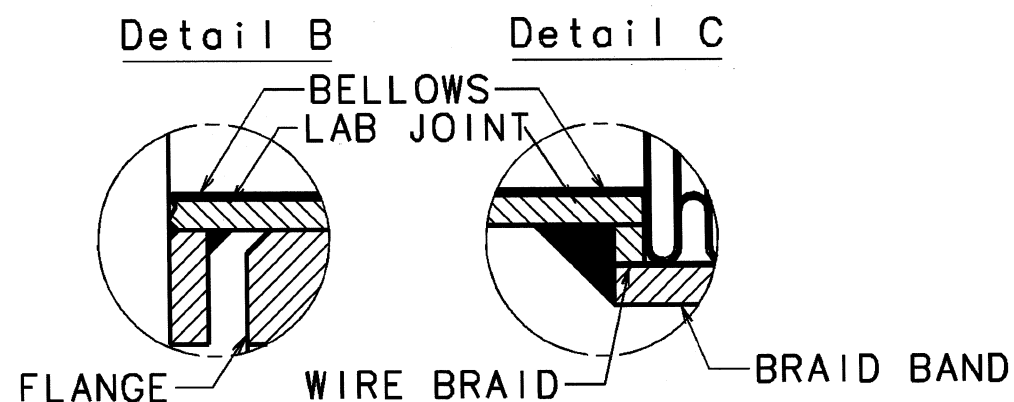
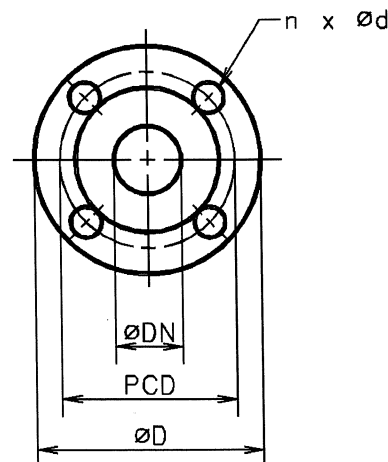
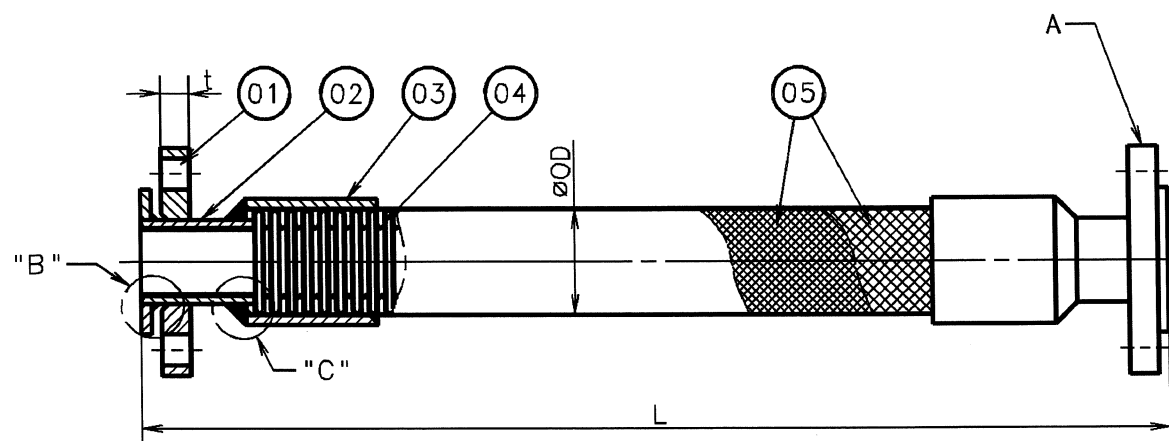
(Figure 4)

External pipe

Fixed support

Gas bellow

Exhaust out duct



Specification

- Max. working pressure : 1.6 MPa, 3 MPa (16bar, 30bar)
- Hose assembly test pressure : 3MPa, 4.5MPa (30bar, 45bar)
- Service temperture range : -20 ~ +100°C
- Medium : Starting air, control air
- Flange connection : JIS B2220 PN16, PN30
- Flexible hose to be pressure tested according to the demands of the classification society.
Flexible hose는 선급이 정하는 규정에따라 압력 테스트할 것.
- A: "Pipe to be stamped with actual test pressure after pressure-test" and DN-number.
A부에 실제 압력 test 및 DN 번호를 표기할 것.
- For welding instruction
see draw. no. B14-100443-8.0.
용접시방은 B14-100443-8.0 에 따라 실시할 것.
- Steel part to be painted with YEOL COAT QT606(SILVER) after sanding&pickling expect machined part.
기계가공면을 제외한 steel부분은 산세와샌딩후 내열페인트 YEOL COAT QT606(은색)페인팅 할것.
- To see instruction for mounting :
drawing no. B11-122888-0.
설치를 위한 지침서는 도면번호 B11-122888-0을 볼것.

No.	Part no.	Info. no.	Nominal press dia.	L(mm)	Flange dimensions				Flexible hose			Mass. (kg)
					PCD	D	t	nxd	OD	Bending radius	Burst press 20°C, kgf/cm ² (Mpa)	
1	B19-102547-7	172359	16K-25	500	90	125	14	4x19	51.6	170	170 (17Mpa)	3.74
2	B19-102548-9	172359	16K-32	500	100	135	16	4x19	63.8	180	160 (16Mpa)	5.44
3	B19-102549-0	172359	16K-40	500	105	140	16	4x19	77.8	200	120 (12Mpa)	6.12
4	B19-102550-0	172359	16K-50	500	120	155	16	8x19	85.2	225	120 (12Mpa)	6.89
5	B19-102551-1	172359	16K-65	500	140	175	18	8x19	102.8	250	90 (9Mpa)	8.25
6	B19-127791-6	172359	30K-20	500	85	120	18	4x19	33.7	160	180 (18Mpa)	3.85
7	B19-102552-3	172359	30K-25	500	95	130	20	4x19	51.6	170	170 (17Mpa)	4.94
8	B19-102553-5	172359	30K-32	500	105	140	22	4x19	63.8	180	160 (16Mpa)	6.68
9	B19-102554-7	172359	30K-40	500	120	160	22	4x23	77.8	200	120 (12Mpa)	8.48
10	B19-102555-9	172359	30K-50	500	130	165	22	8x19	85.2	225	120 (12Mpa)	8.98

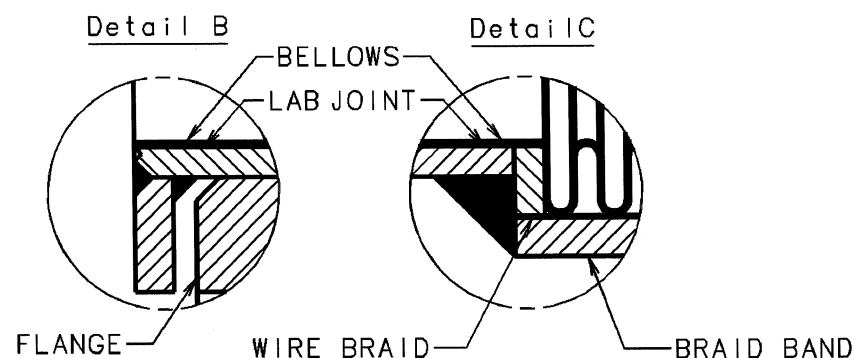
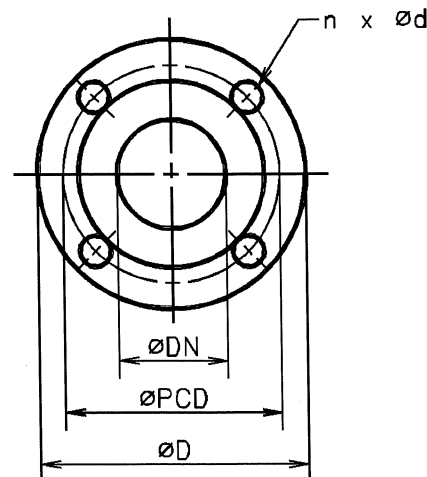
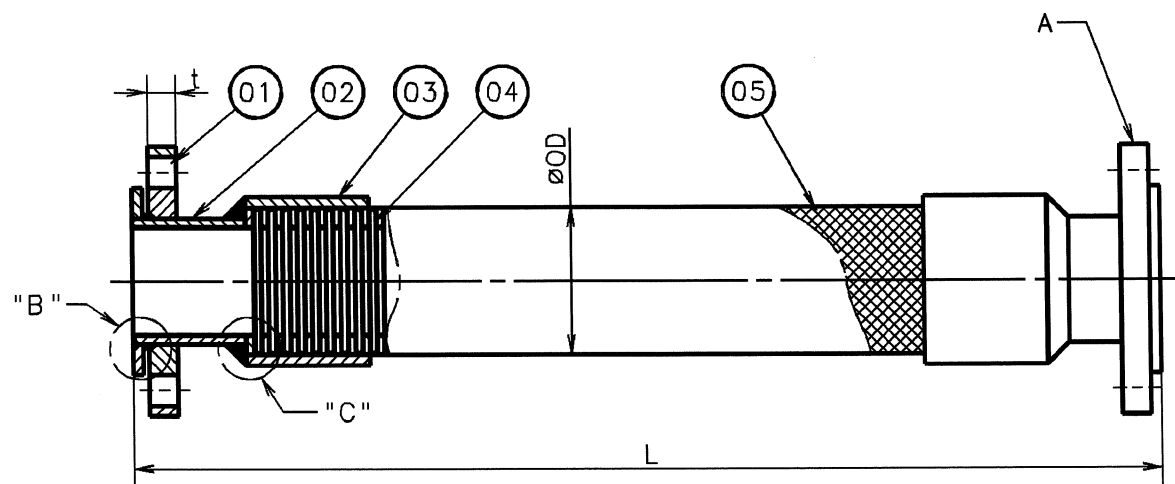
05	122872-3-05	Double Wire braid	SUS304	1	-	-
04	122872-3-04	Bellows	SUS316L	1	-	-
03	122872-3-03	Braid end	SS400	2	-	-
02	122872-3-02	Lab joint	SS400	2	-	-
01	122872-3-01	Flange	SS400	2	-	-
POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
Supplement Drawing No.:						
Projection: Mass (kg):						
Licensor's Ident. no.: 1608223-3.0 Dist.: P82 Licensor's Material / Blank:						
Date	Des.	Chk.	Appd.	A.C.	E	C.No
				*	*	Replaced by ident. No.:
				*	*	
				*	*	
				*	*	
				*	*	
070612	DYJJCMSJR	*	*	*	*	Corrected text.
000412	DYJSMHSHK	*	*	*	*	Changed design. & Added detail.
000125	JHSHJHSKSW	*	*	*	*	Added to part no.
990121	BJHSMHKS	*	*	*	*	Design development
981223	BJHSMHKS	*	*	*	*	Added to part no.
980115	MDJSMHSMH	*	*	*	*	

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1302-1976.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value in µm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768-1989)												
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machine.												
Part	Non-measurement	0.5	over 0.5	over 30	over 120	over 315	over 1000	over 2000	over 5000	over 10000	over 20000	over 50000
Permissible deviation	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±1.6	±2.0	±2.5	±3.0	±4.0	±5.0

Scale:	Size:	Type:	Page No.:	Ident. No.:
1:2.5	A2	-	01 (01)	B12-122872-3
Info. No.:	Description:	Ident. No.:		
372359	Metallic flexible hose	B12-122872-3		



Specification

- Max. working pressure : 0.6 MPa (6 bar)
- Hose assembly test pressure : 1.2 MPa (12 bar)
- Service temperture range : -20 ~ +100°C
- Medium : Diesel fuel oil, lubricating oil
control air, fresh water
leakage fuel oil
- Flange connection : JIS B2220 PN05
- Flexible hose to be pressure tested according to the demands of the classification society.
Flexible hose는 선급이 정하는 규정에 따라 압력 테스트할 것.
- A: "Pipe to be stamped with actual test pressure after pressure-test" and DN-number.
A부에 실제 압력 test 및 DN 번호를 표기할 것.
- For welding instruction
see draw. no. B14-100443-8.
용접시방은 B14-100443-8 에 따라 실시할 것.
- Steel part to be painted with YEOL COAT QT606(SILVER) after sanding&pickling expect machined part.
기계가공면을 제외한 steel부분은 산세와샌딩후 내열페인트 YEOL COAT QT606(은색)페인팅 할것.
- To see instruction for mounting :
drawing no. B11-122888-0.
설치를 위한 지침서는 도면번호 B11-122888-0을 붙것.

No.	Part no.	Info. no.	Nominal press dia.	L(mm)	Flange dimensions				Flexible hose			Mass. (kg)
					PCD	D	t	nxd	OD	Bending radius	Burst press 20°C, kgf/cm ² (Mpa)	
1	B19-102535-8	172359	5K-15	500	60	80	9	4x12	28.3	130	280 (28Mpa)	1.42
2	B19-102536-0	172359	5K-20	500	65	85	10	4x12	33.7	160	200 (20Mpa)	1.67
3	B19-102537-1	172359	5K-25	500	75	95	10	4x12	51.6	170	170 (17Mpa)	2.32
4	B19-102538-3	172359	5K-32	500	90	115	12	4x15	63.8	180	160 (16Mpa)	3.91
5	B19-102539-5	172359	5K-40	500	95	120	12	4x15	77.8	200	120 (12Mpa)	4.50
6	B19-102540-4	172359	5K-50	500	105	130	14	4x15	85.2	225	120 (12Mpa)	5.34
7	B19-102541-6	172359	5K-65	500	130	155	14	4x15	102.8	250	90 (9Mpa)	6.07
8	B19-102542-8	172359	5K-80	500	145	180	14	4x19	119.0	275	65 (6.5Mpa)	8.90
9	B19-102543-0	172359	5K-100	500	165	200	16	4x19	143.3	350	55 (5.5Mpa)	9.60
10	B19-102544-1	172359	5K-125	600	200	235	16	8x19	145.0	425	45 (4.5Mpa)	12.3
11	B19-102545-3	172359	5K-150	600	230	265	18	8x19	172.0	500	38 (3.8Mpa)	16.1
12	B19-102546-5	172359	5K-200	600	280	320	18	8x23	230.0	750	35 (3.5Mpa)	24.7

05	122871-1-05	Single Wire braid	SUS304	1	-	-
04	122871-1-04	Bellows	SUS316L	1	-	-
03	122871-1-03	Braid band	SS400	2	-	-
02	122871-1-02	Lab joint	SS400	2	-	-
01	122871-1-01	Flange	SS400	2	-	-

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS	
Supplement Drawing No.:			Projection: 	Mass (kg):	Material / Blank:		
			Licensor's Ident. no.:	Dial.:	Licensor's Material / Blank:		
			1608223-3.0	P82			
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.
070611	DYJ	JCM	SJR	*	*	Replaced by Ident. No.: Corrected text.	9
060612	JJO	JCM	SJR	*	*	Add. medium	8
000719	DYJ	SMH	SHK	*	*	Del. part no.	7
000412	DYJ	SMH	SHK	*	*	Changed design. & Added detail.	6
000119	JHS	JHS	KSW	*	*	Added Part NO. 04	5
991226	KHG	KHG	KSW	*	*	Revised no.02 stub end material & medium	4
990920	KHG	KHG	KSW	*	*	Revised no.02 stub end material (SS400 / SUS304)	3
990121	BJH	SMH	KSW	*	*	Design development	2
981223	BJH	SMH	KSW	*	*	Added to part no.	1
980115	MDJ	SMH	SMH	*	*		0

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1302-1978.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value in µm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768-1989)									
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machine.									
Permissible deviations	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000	Medium series	±0.1	±0.2
	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2			

Scale:	Size:	Type:	Page No.:	Ident. No.:
1:2.5	A2	-	01 (01)	B12-122871-1
Info. No.:	Description:	Replacement of Ident. No.:		
372359	Swivel type Metallic flexible hose			

HSEF-k210-011(R1)

한도공업(주) 원안사업본부

A2(594mmx420mm) 1/4

COMPENSATOR.

Medium: Sea and fresh cooling water
Lub. oil

Working temperature: 100°C

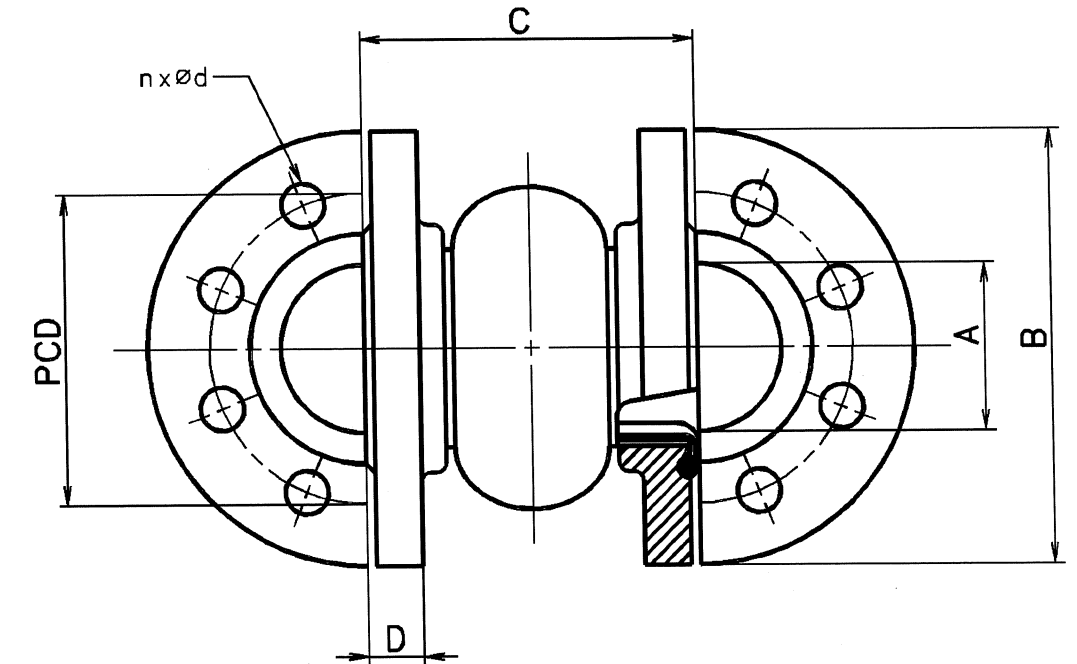
Working pressure : 0.5 MPa (5 bar)

Test pressure : 1 MPa (10 bar)

Material
Flange: SS400
Liner: EPDM (EPT)
Reinforcem: nyloncord
Cover: EPDM (EPT)

CLASSIFICATION:
Shall be in accordance with
the rules of classification valid

LLOYDS REGISTER OF SHIPPING.
DET NORSKE VERITAS.
BUREAU VERITAS.
GERMANISHER LLOYD.
AMERICAN BUREAU OF SHIPPING.
U.S. COAST GUARD.
USSR REGISTER OF SHIPPING.
KOREAN REGISTER OF SHIPPING.

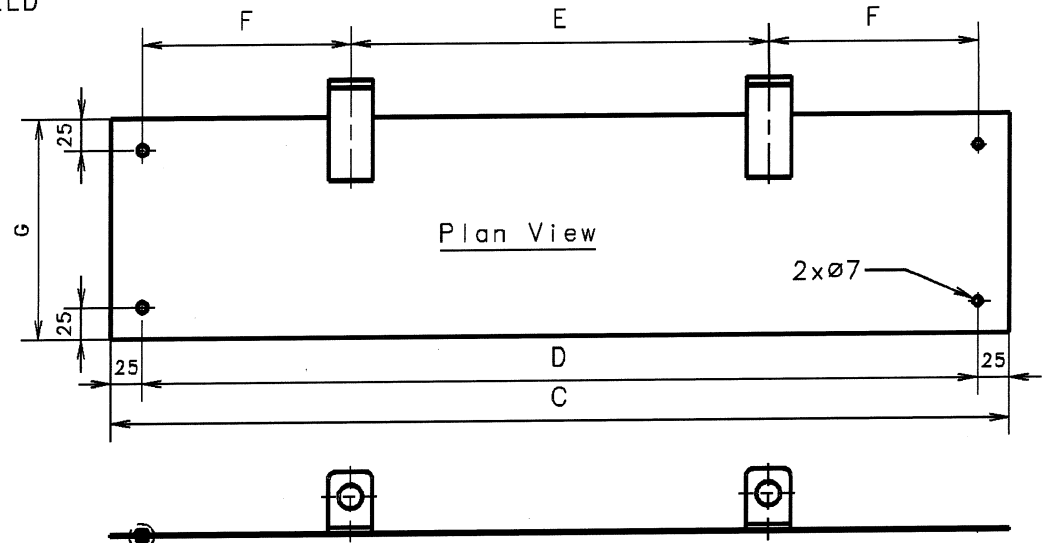
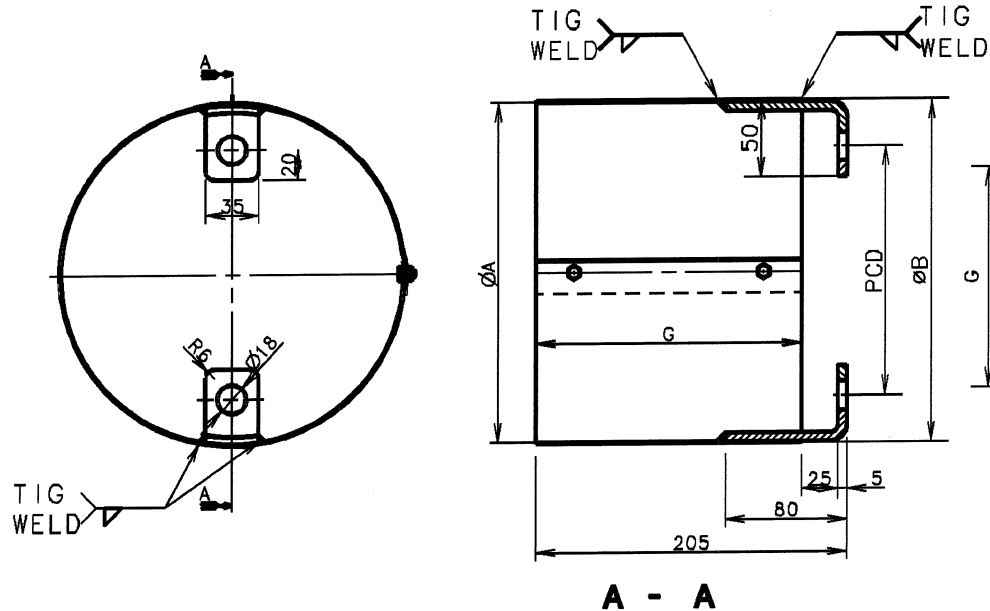


No.	Part no.	Info. no.	Nominal press dia.	C(mm)	Flange dimensions				A	Movement			Weight (kg)
					PCD	B	D	nxd		Axial comp.	Axial expan.	Lateral	
1	B19-189261-0.0	172359	5K-25	130	75	95	10	4x12	25	30	10	10	1.12
2	B19-126328-9.0	172359	5K-32	130	90	115	12	4x15	32	30	10	10	1.81
3	B19-126329-0.0	172359	5K-40	130	95	120	12	4x15	40	30	10	10	1.91
4	B19-126330-0.0	172359	5K-50	150	105	130	14	4x15	50	30	10	10	2.46
5	B19-127602-4.0	172359	5K-65	150	130	155	14	4x15	65	30	10	10	3.43
6	B19-127775-2.0	172359	5K-80	150	145	180	14	4x19	80	40	10	10	4.52
7	B19-127776-4.0	172359	5K-100	150	165	200	16	8x19	100	40	10	10	5.43
8	B19-127778-8.0	172359	5K-125	150	200	235	16	8x19	125	40	10	10	7.31
9	B19-127780-9.0	172359	5K-150	150	230	265	18	8x19	150	40	10	10	9.82
10	B19-127783-4.0	172359	5K-200	175	280	320	20	8x23	200	45	15	15	13.4
11	B19-127785-8.0	172359	5K-250	175	345	385	22	12x23	250	45	15	15	20.1

Supplement Drawing No.:					Projections:		Mass (kg):		Material / Blank:		
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
					P82						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					
				*	*	Replaced by Ident. No.:					
				*	*						
				*	*						
070612	DYJ	JCMSJR		*	*	Corrected text.					
051205	JHS	JCMSJR		*	*	Added weight					
020531	DYJ	DYJSMH		*	*	Changed spec. (Work temp : 90°C -> 100°C)					
010613	YJB	YJB SMH		*	*	No.7(5k-100A) modified and No.1(5k-25A) added					
000609	JJO	JJO SMH		*	*	Design development					
991104	JHS	JHSKSW		*	*	Changed Part no.					
991008	KHG	KHGKSW		*	*						
Similar Drawing No.:						Replacement of Ident. No.:					
Scale: A2						Page No.: 01 (01)					
Info. No.: 399986						Description: Compensator					
Ident. No.: B12-130471-9											

Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1302-1978.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value in	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768-1989)												
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.												
Permissible deviations	0,5	over 0,5	over 30	over 120	over 315	over 1000	over 2000	over 5000	over 10000	over 20000	over 50000	over 100000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±1,6	±2,5	±4	±6,3	±10	±16



221.R6.105008 (To be welded on plate)

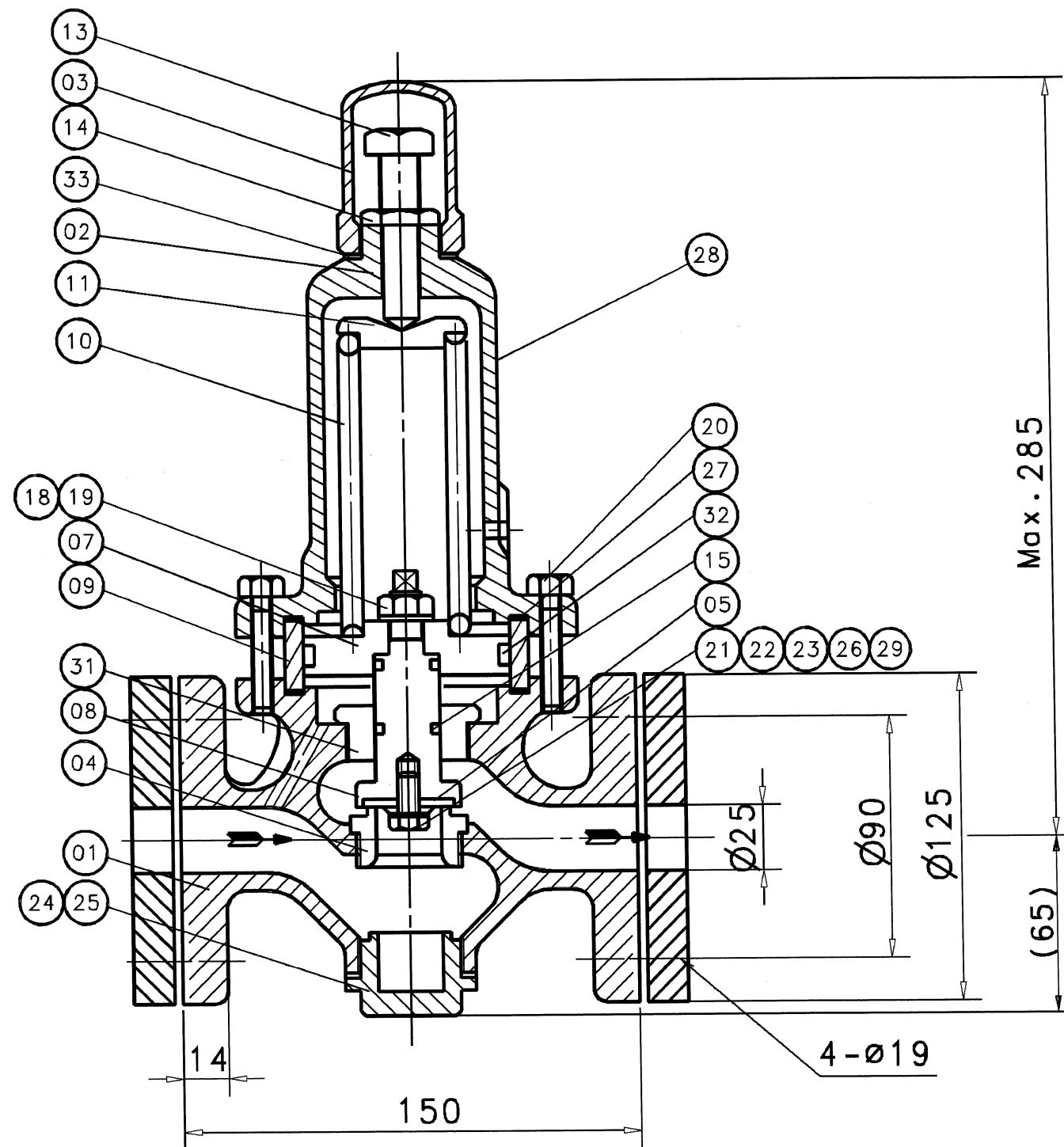
250.R1.105000

DN	PCD	ØA	ØB	C	D	E	F	G	PART NO.
25	75	135	137	474	424	212	106	150	B19-195517-6
32	90	155	157	537	486	243	122	150	B19-195518-8
40	95	160	162	553	502	251	126	150	B19-195519-0
50	105	170	172	584	534	267	133.5	175	B99-007142-6
65	130	195	197	663	613	307	153.5	175	B99-007143-8
80	145	210	212	710	660	330	165	175	B99-007144-0
100	165	230	232	773	723	362	181	175	B99-007145-1
125	200	265	267	882	832	416	208	175	B99-007146-3
150	230	295	297	975	925	463	231.5	175	B99-007147-5
200	280	345	347	1134	1084	542	271	175	B99-007148-7
250	345	410	412	1338	1288	644	322	175	B99-007149-9

Supplement Drawing no.:					Projection:		Mass (kg):		Material / Blank:		
					Licensor's Ident. no.: 1627358-0		Dist.:		Licensor's Material / Blank:		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No	
				*	*	Replaced by Ident. No.:				9	
				*	*					8	
				*	*					7	
				*	*					6	
				*	*					5	
				*	*					4	
				*	*					3	
				*	*					2	
				*	*					1	
060117JHSJCMSJR					*	*	Added 25A, 32A, 40A				0
051118DYJJCMSJR					*	*					
Similar Drawing No.:						Replacement of Ident. No.:					
Scale:	Size:	Type:				Page No.:		01 (01)			
399988			Description:			Guard			Ident. No.:		
									B93-015145-7		

PLAN HISTORY				ENGINE TYPE		HYUNDAI - HIMSEN H21/32	
Title : Counter flanges, Gaskets, Bolts & Nuts							
Description		Drawing no.		Part no.		Q'ty/ Eng.	
Flange 5K-15		400.B1.105015		-		1	
Flange 5K-25		400.B1.105025		-		3	
Flange 5K-65		400.B1.105065		-		1	
Flange 5K-80		400.B1.105080		-		2	
Flange 16K-25		400.DA.116025		-		2	
Flange 30K-40		400.DA.130040		-		1	
Gasket 5K-15		460.87.022048		-		2	
Gasket 5K-25		460.87.035062		-		6	
Gasket 5K-65		460.87.077115		-		2	
Gasket 16K-25		460.87.035070		-		4	
Gasket 30K-40		460.87.048090		-		2	
Bolt M10x35		220.R6.110035		-		32	
Bolt M12x40		220.R6.112040		-		8	
Bolt M16x40		220.R6.116040		-		48	
Bolt M20x55		220.R6.120065		-		8	
Nut M10		250.R1.111000		-		32	
Nut M12		250.R1.112000		-		8	
Nut M16		250.R1.116000		-		48	
Nut M20		250.R1.120000		-		8	
Spring washer M10		270.SB.110000		-		32	
Spring washer M12		270.SB.112000		-		8	
Spring washer M16		270.SB.116000		-		48	
Spring washer M20		270.SB.120000		-		8	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
				*			
071107	JHJ	JCMSJR		*	Replacement for Ident.no.: FOR H21/32 (5.6Cyl.)		
Licensor Ident.no.:				Type:			
Info.no.:				Description:			
075000				Counter flanges, gaskets			
Page.no.:				bolts & nuts			
01 OF 01				Ident.no.:			
				B94-029619-8			





*** SPECIFICATION ***

1. Setting pressure : 2 bar (0.2 MPa)
2. Test pressure : 9 bar (0.9 MPa)
3. Working pressure : Max. 6 bar (0.6 MPa)
4. Working temperature : Max. 55°C
5. Medium : MDO
6. Flange size : JIS B2220 16K-25
7. Flow direction to be marked.
8. Setting pressure & Description to be marked on name plate.
9. To be supplied counter flanges, gaskets, bolts & nuts by valve maker.

33	-	GASKET	TBAAF2100	1	-	-
32	-	O-RING	VITON	1	-	-
31	-	STEM GUIDE	SUS304	1	-	-
30	-	-	-	-	-	-
29	-	PLUG	S45C	1	-	-
28	-	NAME PLATE	SUS304	1	-	-
27	-	GASKET	TBAAF2100	1	-	-
26	-	AIR PIN	C3712BE	2	-	-
25	-	PLUG	SUS304	1	-	-
24	-	GASKET	TBAAF2100	1	-	-
23	-	DISC LOCK BOLT	SUS304	1	-	-
22	-	SPRING WASHER	SWRM10	1	-	-
21	-	DISC SCREW	SS 400	1	-	-
20	-	BOLT	SS 400	6	-	-
19	-	STEM LOCK NUT	SS 400	1	-	-
18	-	SPRING WASHER	SWRM10	1	-	-
17	-	-	-	-	-	-
16	-	-	-	-	-	-
15	-	O-ring	VITON	2	-	-
14	-	LOCK NUT	SUS304	1	-	-
13	-	ADJUST SCREW	SS 400	1	-	-
12	-	-	-	-	-	-
11	-	T-SPRING SEAT	SS 400	1	-	-
10	-	SPRING	SWOSC-V	1	-	-
09	-	CYLINDER	STKM13C	1	-	-
08	-	STEM	FPM	1	-	-
07	-	PISTON	SUS304	1	-	-
06	-	-	-	-	-	-
05	-	DISC	VITON	1	-	-
04	-	SEAT	SUS304	1	-	-
03	-	Cap	FC 200	1	-	-
02	-	SPRING CASE	SRPG370	1	-	-
01	-	Body	FCD 400	1	-	-

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
--------	------------	-------------	-------	------	---------	---------

Supplement Drawing No.:		Projections: 		Mass (kg):	Material / Blank:
		Licensor's Ident. no.:		Dist.:	Licensor's Material / Blank:

[illegible]

080407	JCL	KJGSJR	*	*	Corrected note.
--------	-----	--------	---	---	-----------------

071221	JCL	JCM	SJR	*	*	With counter flange
--------	-----	-----	-----	---	---	---------------------

Similar Drawing No.:		Replacement of Ident. No.:	
		Page No.:	
		ALM 1234	

Scale:	Size:	Page No.:	
1:2	A2	01 (01)	

1000 2000	Info. No.: 399974	Description: Pressure regulating valve for M.D.O. outlet (2 bar)	Ident. No.: B92-029616-
--------------	----------------------	--	----------------------------

HSEF-k210-Q11 (R1)

현대중공업(주) 엔진사업본부

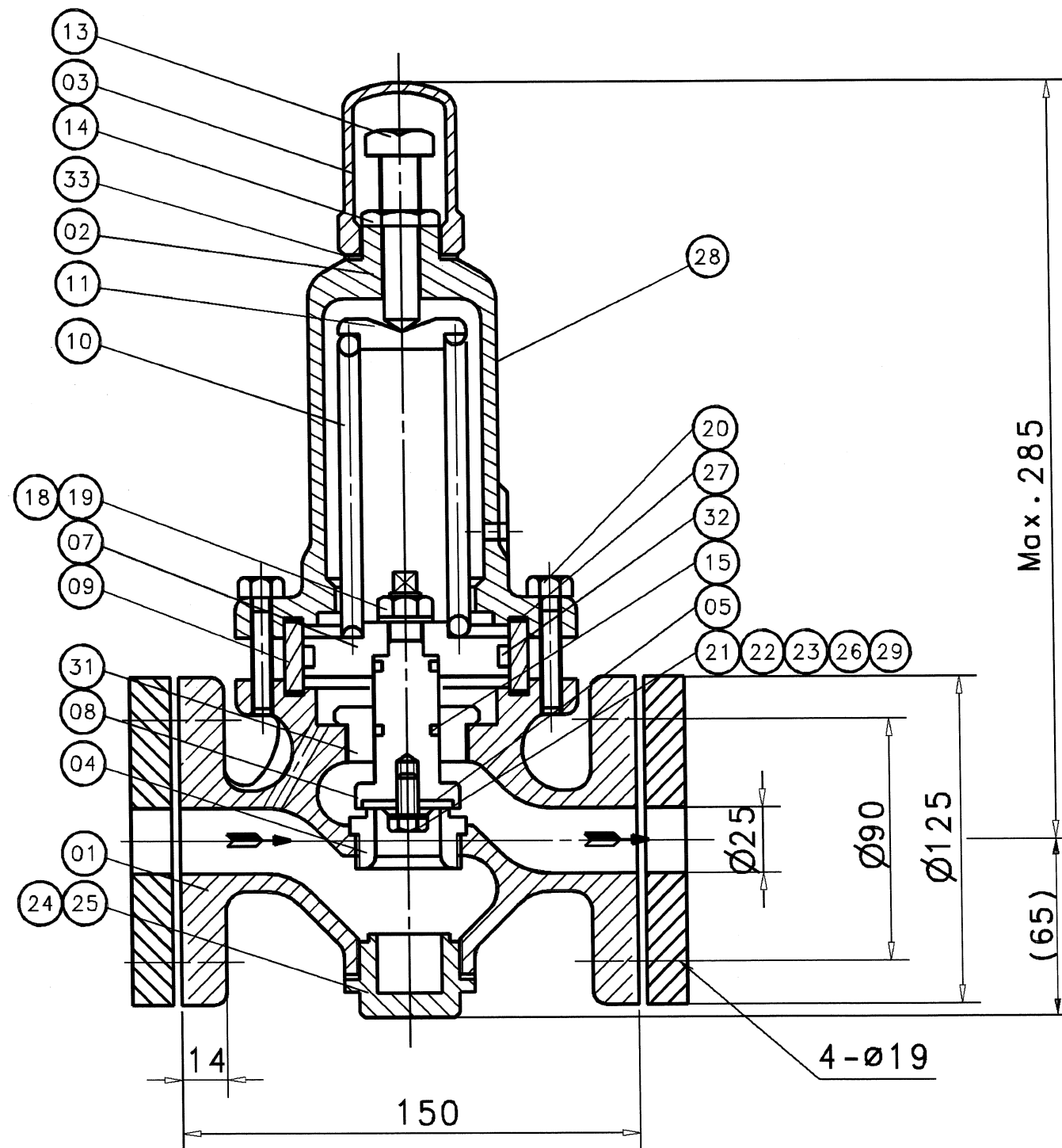
A2 (594mm×420mm) 黒面印刷

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

이 도면과 보충도면은 HHI-EMD의 소유이며 저작권에 의해 보호됩니다. 이 도면은 오직 HHI-EMD의 제품 제조, 수리 또는 사용만을 위하여 recipient에게 제공되며, HHI-EMD와 체결한 계약 또는 다른 서면 합의에 따라만 HHI-EMD의 제품을 제조, 수리 또는 사용하는데 사용될 수 있습니다. 이 도면은 전체 또는 일부가 복사, 재현, 공개 또는 다른 어떤 방식으로든 HHI-EMD의 서면 동의 없이 제3자에게 제공될 수 없습니다. 이 도면은 제3자에게 직접 또는 상속을 통해 HHI-EMD의 권리를 넘겨줄 수 없습니다.

Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1302-1978.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _{max} , value in μm	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768-1989)						
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.						
Nom. measurement	0,5	0,5	0,5	0,5	0,5	0,5
Permissible deviations	up to 8	up to 30	up to 120	up to 315	up to 1000	up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2



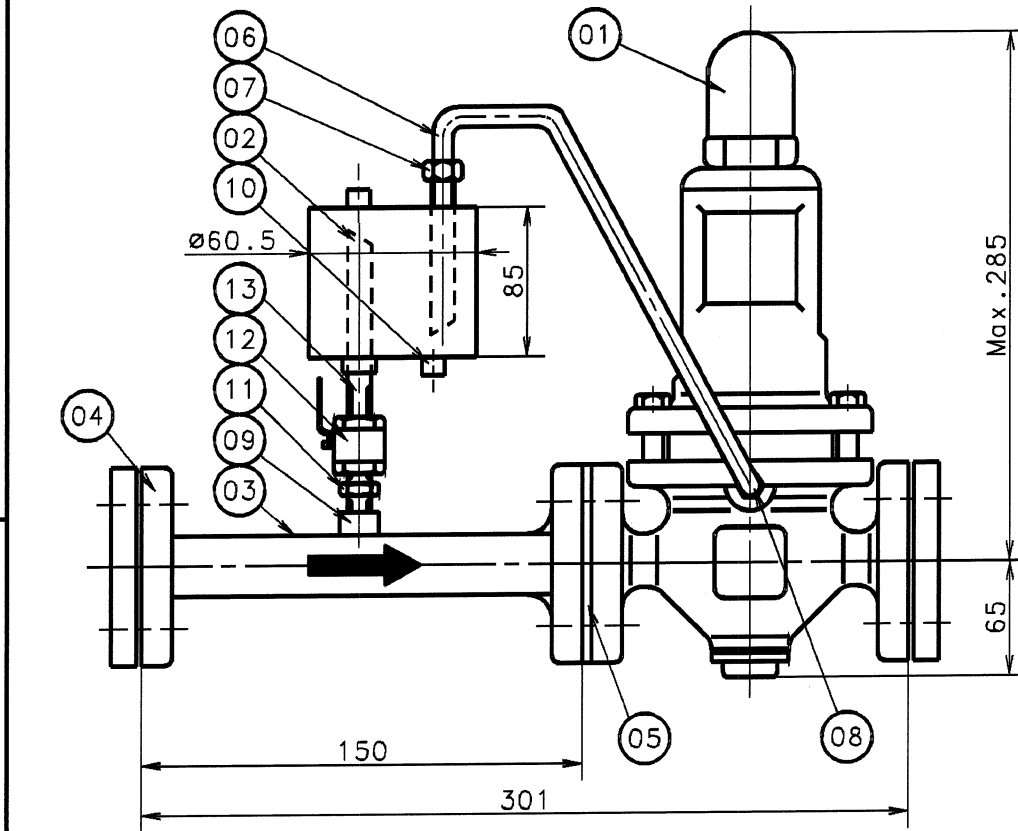
SPECIFICATION

1. Setting pressure : 6 bar (0.6 MPa) 
2. Test pressure : 9 bar (0.9 MPa)
3. Working pressure : Max. 6 bar (0.6 MPa)
4. Working temperature : Max. 55°C
5. Medium : MDO
6. Flange size : JIS B2220 16K-25
7. Flow direction to be marked.
8. Setting pressure & Description to be marked on name plate.
9. To be supplied counter flanges, gaskets, bolts & nuts by valve maker.

33	-	GASKET	TBAAF2100	1	-	-
32	-	O-RING	VITON	1	-	-
31	-	STEM GUIDE	SUS304	1	-	-
30	-	-	-	-	-	-
29	-	PLUG	S45C	1	-	-
28	-	NAME PLATE	SUS304	1	-	-
27	-	GASKET	TBAAF2100	1	-	-
26	-	AIR PIN	C3712BE	2	-	-
25	-	PLUG	SUS304	1	-	-
24	-	GASKET	TBAAF2100	1	-	-
23	-	DISC LOCK BOLT	SUS304	1	-	-
22	-	SPRING WASHER	SWRM10	1	-	-
21	-	DISC SCREW	SS 400	1	-	-
20	-	BOLT	SS 400	6	-	-
19	-	STEM LOCK NUT	SS 400	1	-	-
18	-	SPRING WASHER	SWRM10	1	-	-
17	-	-	-	-	-	-
16	-	-	-	-	-	-
15	-	O-ring	VITON	2	-	-
14	-	LOCK NUT	SUS304	1	-	-
13	-	ADJUST SCREW	SS 400	1	-	-
12	-	-	-	-	-	-
11	-	T-SPRING SEAT	SS 400	1	-	-
10	-	SPRING	SWOSC-V	1	-	-
09	-	CYLINDER	STKM13C	1	-	-
08	-	STEM	FPM	1	-	-
07	-	PISTON	SUS304	1	-	-
06	-	-	-	-	-	-
05	-	DISC	VITON	1	-	-
04	-	SEAT	SUS304	1	-	-
03	-	Cap	FC 200	1	-	-
02	-	SPRING CASE	SRPG370	1	-	-
01	-	Body	FCD 400	1	-	-

POS NO	DRAWING NO	DESCRIPTION				MAT'L	Q'TY	KG/UNIT	REMARKS
Supplement Drawing No.:		Projections:		Mass (kg):		Material / Blank:			
				10.5					
		Licensor's Ident. no.:			Dist.:		Licensor's Material / Blank:		
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement			C.No
				*	*	Replaced by Ident. No.:			9
				*	*				8
				*	*				7
				*	*				6
				*	*				5
				*	*				4
				*	*				3
				*	*				2
080407	JCLKJGSJR	*	*	Corrected setting pressure			1		
071221	JCLJCMSJR	*	*	With counter flange			0		

Standard for surface roughness													Tolerances for dimensions without tolerance indication (ISO 2768-1988)						
The basic symbols and class numbers are in accordance with ISO 1302-1978.													This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.						
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	Nom. measurement						
													Permissible deviations	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
R _a max.	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50	Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2



*** SPECIFICATION ***

1. Setting pressure : 9 bar(0.9MPa)
2. Test pressure : 15 bar(1.5MPa)
3. Working pressure : 10 bar(1.0MPa)
4. Operating temp. : 150°C
5. Medium : Heavy fuel oil
6. Flange size : JIS B 2220 16K-25
7. Flow direction to be marked.
8. Setting pressure & Description to be marked on name plate.
9. To be supplied counter flanges, gaskets, bolts & nuts by valve maker.

13	-	Connector	SUS304	1	-	-
12	-	Ball valve	SUS304	1	-	-
11	-	Nipple	SUS304	1	-	-
10	-	Plug	SS400	2	-	-
09	-	Boss	S45C-N	1	-	-
08	-	Connector	SUS304	1	-	-
07	-	Connector	S45C-N	2	-	-
06	-	Tube	St37.4	1	-	-
05	-	Gasket	Non-Asbestos	1	-	-
04	-	Flange	SS400	2	-	-
03	-	Pipe	STPG370	-	-	#40
02	-	Oil separator	STPG370	1	-	-
01	B12-132768-7	Body	FCD400	1	-	B19-192192-1

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
--------	------------	-------------	-------	------	---------	---------

Supplement Drawing no.:	Projection:	Mass (kg):	Material / Blank:
	13.2		
	Licensor's Ident. no.:	Dist.:	Licensor's Material / Blank:
		P82	

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
				*	*		1
				*	*		0

071221JCLJCMSJRI	Similar Drawing No.:	B93-015127-0	Replacement of Ident. No.:	
Scale:	Size:	Type:	Page No.:	
N/S	A3	-	01 (01)	
Info. No.:	Description:	Ident. No.:		
399974	Pressure regulating valve for HFO(9bar)	B93-029618-6		

HSEF-k210-012(R1)

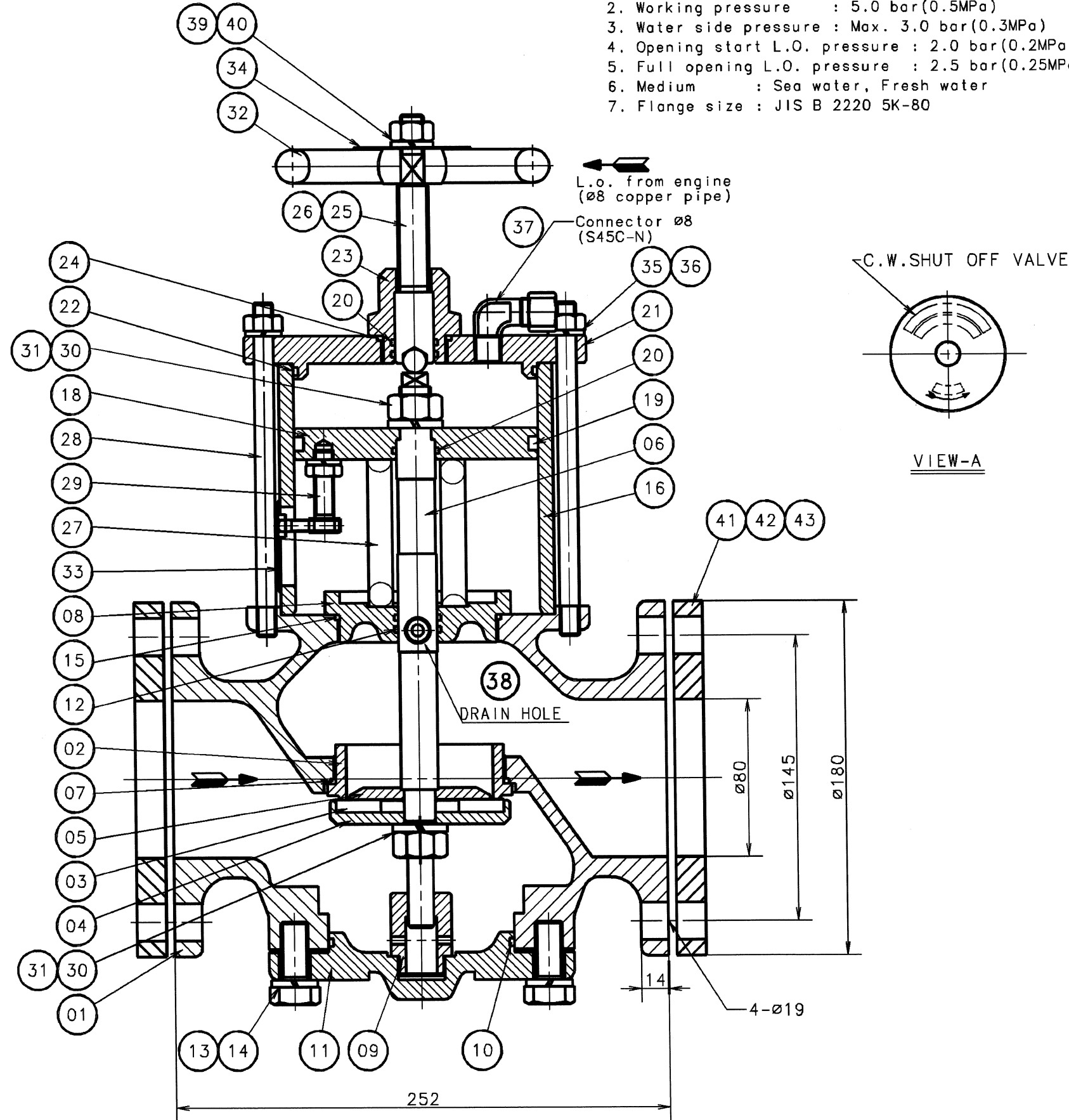
현대중공업(주) 엔진사업본부

A3(420mmx297mm)표준형

C/D Drawing - do not correct by hand

SPECIFICATION

1. Test pressure : 7.5 bar(0.75MPa)
2. Working pressure : 5.0 bar(0.5MPa)
3. Water side pressure : Max. 3.0 bar(0.3MPa)
4. Opening start L.O. pressure : 2.0 bar(0.2MPa)±10%
5. Full opening L.O. pressure : 2.5 bar(0.25MPa)±10%
6. Medium : Sea water, Fresh water
7. Flange size : JIS B 2220 5K-80



43	-	BOLT, NUT, WASHER	SS400	8	-	-
42	-	GASKET	AFM37	2	-	-
41	-	COUNTER FLANGE 5K-80	SS400	2	-	JIS B2220
40	-	Washer	SWRM10	1	-	-
39	-	Nut	SUS304	1	-	-
38	-	Drain plug	C3712BE	1	-	-
37	-	Connector	C3712BE	1	-	-
36	-	Washer	SWRM10	6	-	-
35	-	Nut	SUS304	6	-	-
34	-	Name-plate	SUS304	1	-	-
33	-	Scale	AL	1	-	-
32	-	Handle	FC200	1	-	-
31	-	Washer	SWRM10	2	-	-
30	-	Nut	SUS304	2	-	-
29	-	Indicator	SS400	1	-	-
28	-	Stud bolt	SS400	6	-	-
27	-	Spring	SWOSC-V	1	-	-
26	-	Ball	SUS304	1	-	-
25	-	Screw	C3712BE	1	-	-
24	-	O-ring	NBR	1	-	-
23	-	Bushing	C3712BE	1	-	-
22	-	O-ring	NBR	1	-	-
21	-	Cylinder cover	SS400	1	-	-
20	-	O-ring	NBR	3	-	-
19	-	O-ring	NBR	1	-	-
18	-	Piston	SS400	1	-	-
16	-	Cylinder	STKW13C	1	-	-
15	-	O-ring	NBR	2	-	-
14	-	Washer	SWRM10	4	-	-
13	-	Nut	SUS304	4	-	-
12	-	O-ring	NBR	2	-	-
11	-	Cover	BC6	1	-	-
10	-	O-ring	NBR	1	-	-
09	-	Stem guide	SUS304	1	-	-
08	-	Spring seat	BC6	1	-	-
07	-	O-ring	NBR	1	-	-
06	-	Stem	SUS304	1	-	-
05	-	Disc washer	SUS304	1	-	-
04	-	Disc holder	SUS304	1	-	-
03	-	Disc	NBR	1	-	-
02	-	Seat	BC6	1	-	-
01	-	Body	BC6	1	-	-

POS NO	DRAWING NO				DESCRIPTION			MAT'L	Q'TY	KG/UNIT	REMARKS		
Supplement Drawing No.:					Projections: 		Mass (kg):		Material / Blank:				
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:				
							P8E						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement						C.No	
				*	*	Replaced by Ident. No.:						9	
				*	*							8	
				*	*							7	
				*	*							6	
				*	*							5	
				*	*							4	
				*	*							3	
				*	*							2	
				*	*							1	
071101JCLJCMSJR					*	*	Shut off valve with counter flange.						0
Similar Drawing No.:							Replacement of Ident. No.:					B12-129758-4.5	
Scale:		Size:		Type:			Page No.:						
N/S		A2		-			01 (01)						
Info. No.:		399945				Description:				Ident. No.:			
						Water shut-off valve 80A				B92-027626-0			

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value μm	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

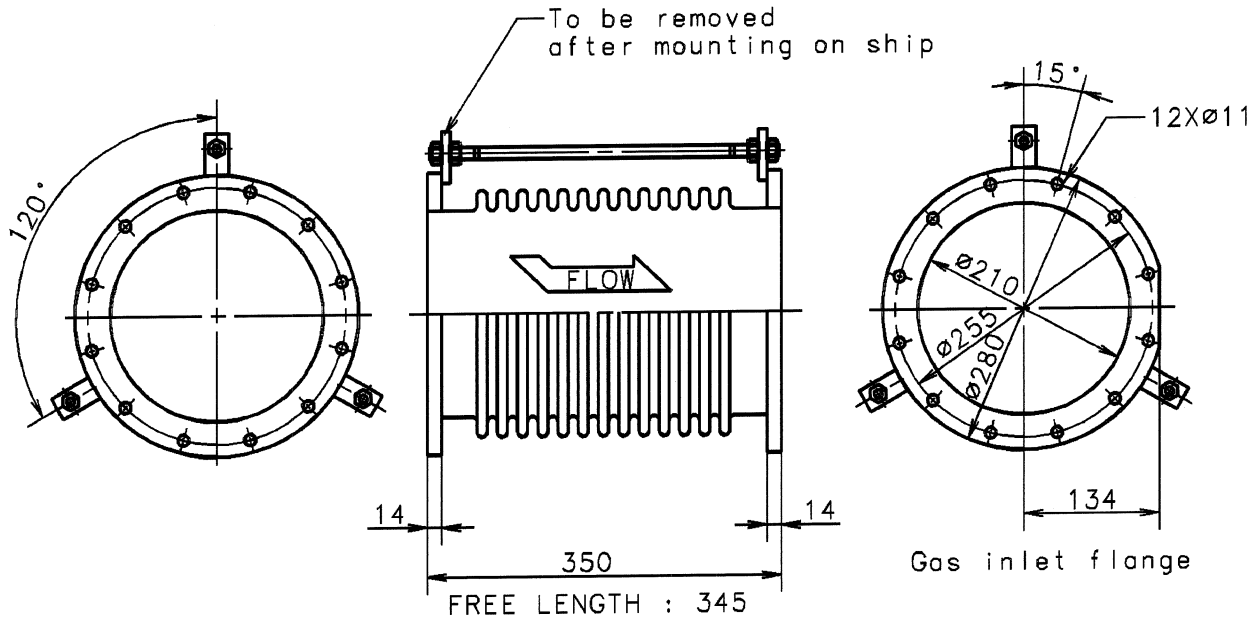
Permissible deviations	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

HSEF-K210-011(R1)

한도중공업(주) 엔진사업본부

A2(594mmx420mm) 1/8

Max. working conditions		Movement		SPRING RATE		Bellows			Life cycle	* Material			
Temp °C	Pressure Bar	Axial in mm (lateral=0)	Lateral in mm (axial=0)	AX CA N/mm	LAT CL N/mm	Number of convolut.	Number of plies	One ply in mm			Flange	Bellows	
550	0.1	±80	±40	43	16	Makers choice	min. 3 plies	Makers choice	min. 6000		SS400	SUS316 or 321	



302 To be marked with
마킹할 것
B93-011552-0 -업체명, 년도/월

* FLANGE TYPE : SPECIAL TYPE.
* ENGINE MOUNTING : RESILIENT

NOTE

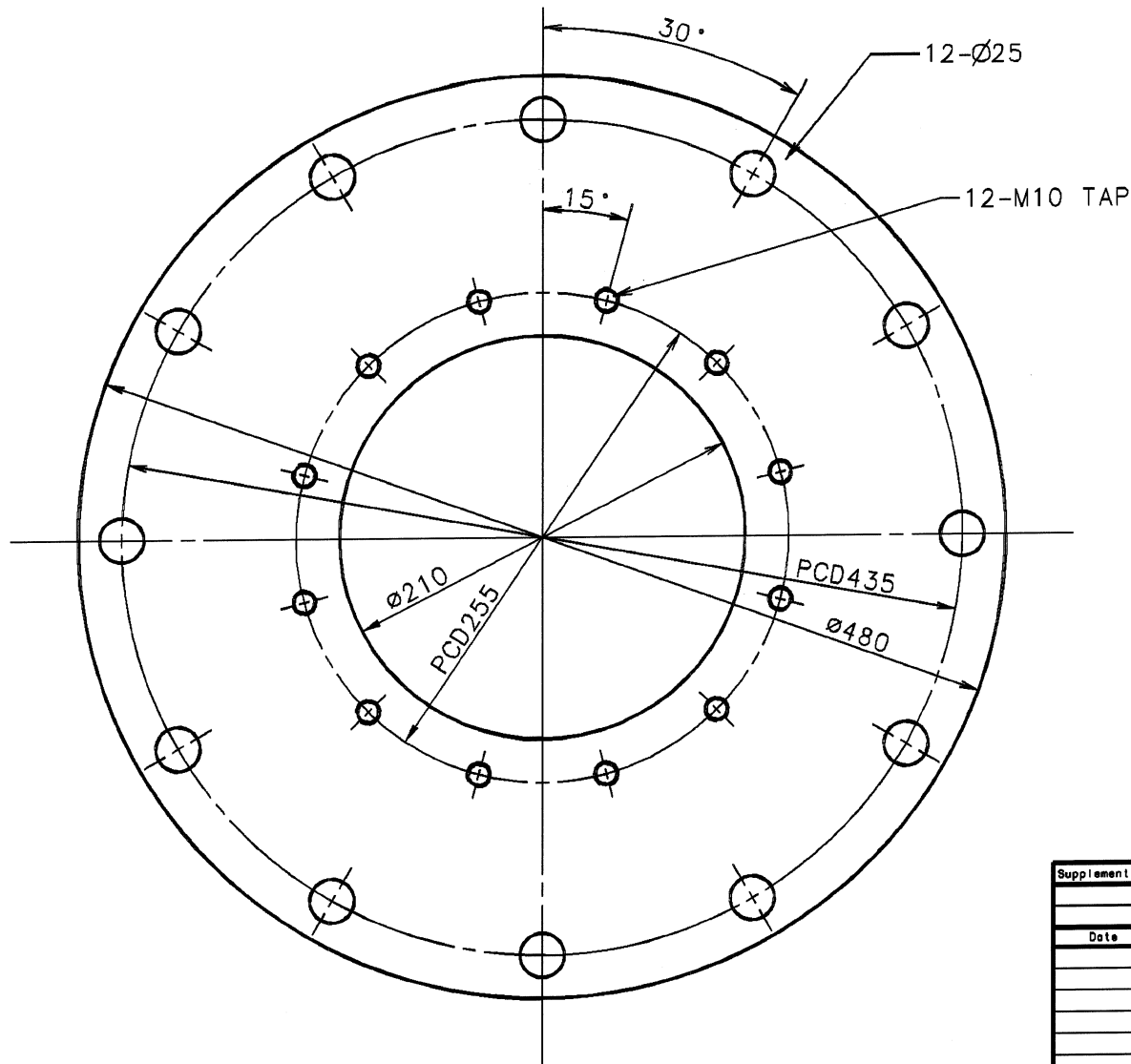
- ALL WELDS OF BELLWS SHOULD BE INSPECTED COLOR CHECK.
- HEAT RESISTANCE SILVER PAINT SHALL BE APPLIED 2 COATS.
- FLOW DIRECTION TO BE MARKED ON THE BODY AS A ARROW.
- THE LENGTH TO BE SETTED WITH 3PCS GUIDE BAR, NOT LONGER THAN SETTING LENGTH.

Supplement Drawing No.:					Projection: 		Mass (kg): 14		Material / Blank:	
					Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:	
							A82			
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				
				*	*	Replaced by Ident. No.:				
				*	*					
				*	*					
				*	*					
				*	*					
				*	*					
				*	*					
080219	KHAKSW	KSW		*	*	ADDED Flange type.				
051013	JSCKSRSJR			*	*	Modified flange				
050216	YKSKSR	KSR		*	*	ADDED SPEC.				
041104	YKSKSR	KSR		*	*					
Similar Drawing No.:						Replacement of Ident. No.:				
Scale:	Size:	Type:	TPS48/HPR3000			Page No.:		01 (01)		
0.2	A3									
Info. No.:		Description:				Ident. No.:				
		EXPANSION JOINT FOR T/C OUTLET				B93-011552-0				

HSEF-k210-012(R1)

현대중공업 (주) 엔진사업본부

A3(420mm×297mm)트리실지

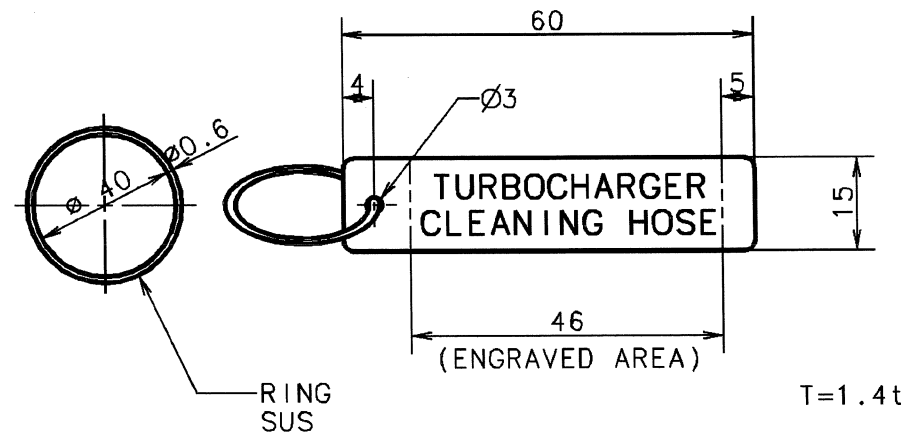
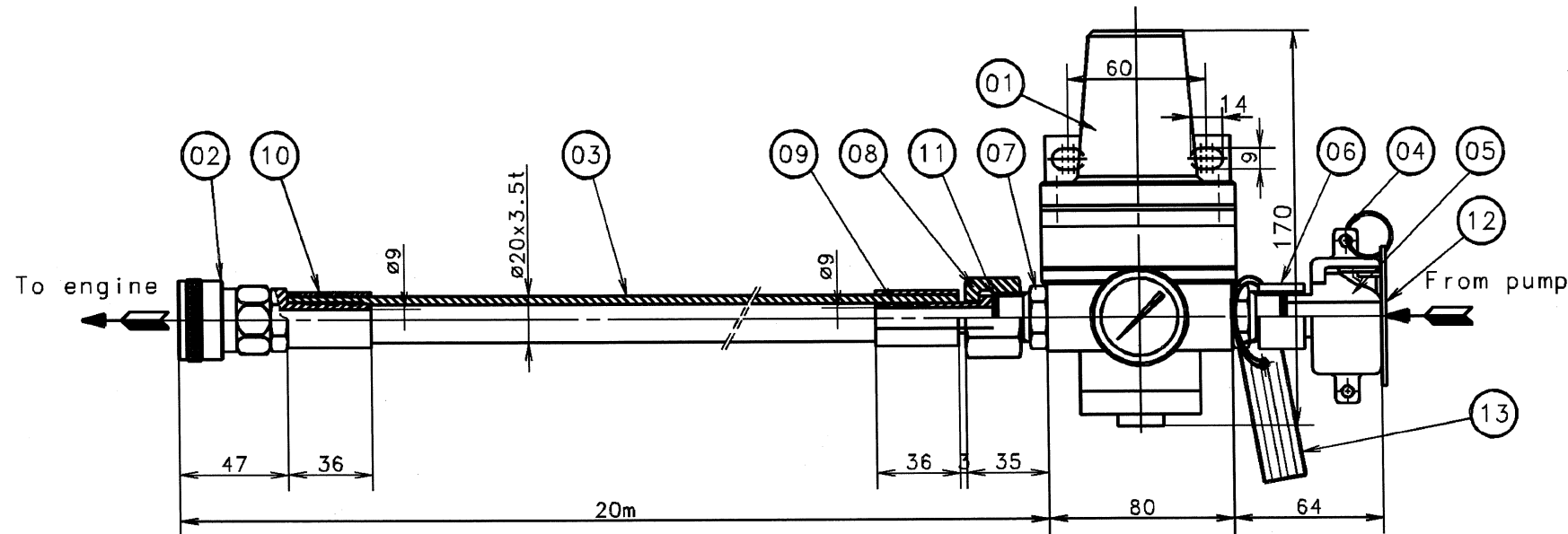


ALL OVER Ra6.3
날카로운 모서리는 제거할 것.
TH'K=18MM

Supplement Dwg no.:				Projection:  20		Mass (kg): 20		Material / Blank: SS400			
				Licensor's Ident. no.:		Dist.: A82		Licensor's Material / Blank:			
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No	
					*	*	Replaced by Ident. No.:				9
					*	*					8
					*	*					7
					*	*					6
					*	*					5
					*	*					4
					*	*					3
					*	*					2
080731	KHA	KSW	KSW		*	*	TYPE 수정				1
071224	LKM	KSW	KSW		*	*	TYPE 수정				0
050608	YKS	KSR	KSR		*	*					
Similar Drawing No.:						Replacement of Ident. No.:					
Scale:	Size:	Type:				H17/28, H21/32		Page No.:			
1:1	A3							01 (01)			
Info. No.:		Description:						Ident. No.:			
000000		TRANSITION PIECE (HPR3000&TPS48)						B93-014755-6			

SPECIFICATION

1. Test pressure : 1.0 MPa (10 bar) ⚠
2. Inlet pressure : Max. 0.7 MPa (7 bar)
3. Operating range : 0.01 ~ 0.7 MPa (0.1 ~ 7 bar)
4. Hose bursting press. : 17 MPa (170 bar)
5. Temperature range : -5°C~60°C
6. Pump side connection : Hose connector for JIS F7334-hose valve
7. Hi-coupler type : ASIA NIPPLE SH400-1/2"
8. Medium : Fresh water 청수
9. Hose color : Blue 청색
10. Regulating valve Rc1/2 : 0.01 ~ 0.7 MPa (0.1 ~ 7 bar) ⚠



DETAIL-NAME PLATE

13	-	Name Plate	C2801P-1/2H	1	-	-
12	-	Plastic cover	Plastic	1	0.01	-
11	-	Gasket	C1100P-0	2	0.01	-
10	-	Hose band	SUS304	2	0.04	-
09	-	Hose connector	SUS304	1	0.06	-
08	-	Union nut PF1/2	SUS304	1	0.05	-
07	-	Nipple PT1/2xPF1/2	SUS304	2	0.26	-
06	-	Socket PF1/2x25	SUS304	1	0.05	-
05	JISF 7335-15C	Hose connector	C3604BD	1	0.50	-
04	JISF 7335-15C	Union nut M42x2	C3604BD	1	0.50	-
03	B-08series-013	Vinyl chloride resin hose	-	1	2.58	012x3.5t20m
02	SH400-1/2"	Hi-coupler socket 1/2"	SUS304	1	0.20	-
01	IR402-04BG	Regulating valve Rc1/2	-	1	1.00	-

POS NO	DRAWING NO		DESCRIPTION			MAT'L	Q'TY	KG/UNIT	REMARKS
Supplement Drawing No.:			Projections: 		Mass (kg): 5.26		Material / Blank:		
			Licensor's Ident. no.:			Dist.:		Licensor's Material / Blank:	
Date		Des.	Chk.	Appd.	A.C.	E	Change / Replacement		C.No
					*	*	Replaced by Ident. No.:		9
					*	*			8
					*	*			7
					*	*			6
					*	*			5
070618		JCL	JCMSJR		*	*	Corrected text		4
040302		JHSSMH	SMH		*	*	Changed test pressure		3
020124		JJOSMH	SMH		*	*	Revised specification		2
990708		JHSSMH	SKSW		*	*	Added No.13		1
951015		KHGS	MHILCS		*	*			0

not correct by hand

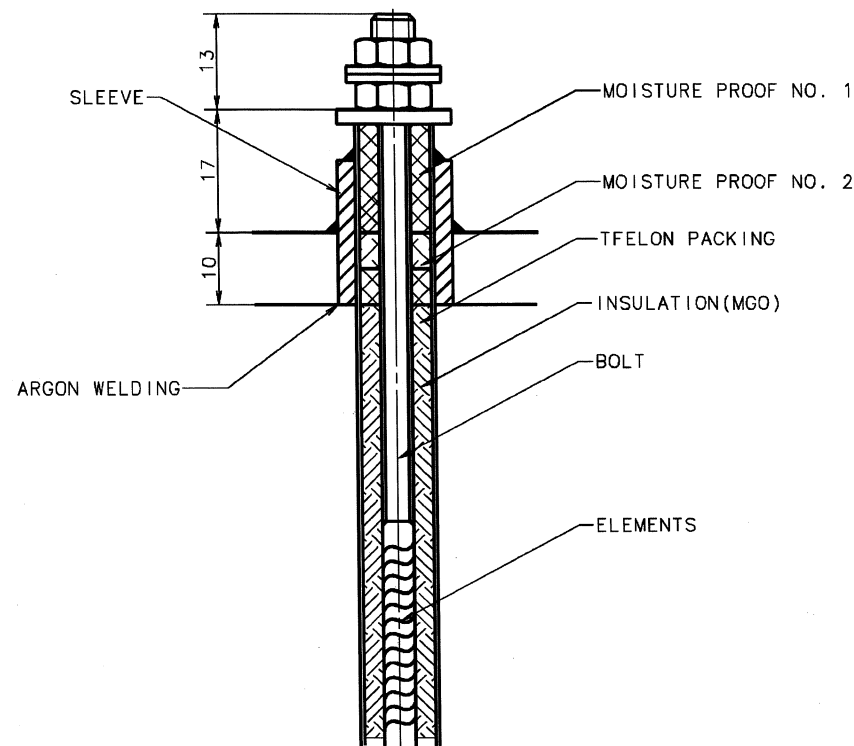
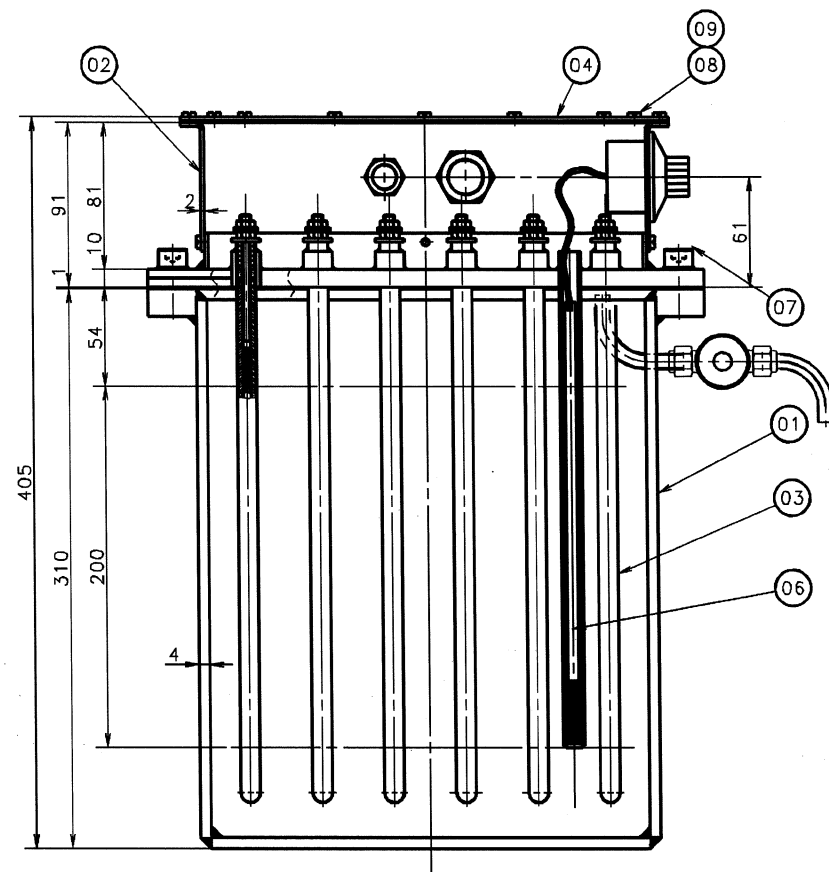
Similar Drawing No.:	B13-100381-1.2	Replacement of Ident. No.:	
Scale:	1:2	Size:	A2
Page No.:	01 (01)	Ident. No.:	B12-116265-8
Info. No.:	592534	Description:	Turbocharger cleaning hose

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Permissible deviations	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

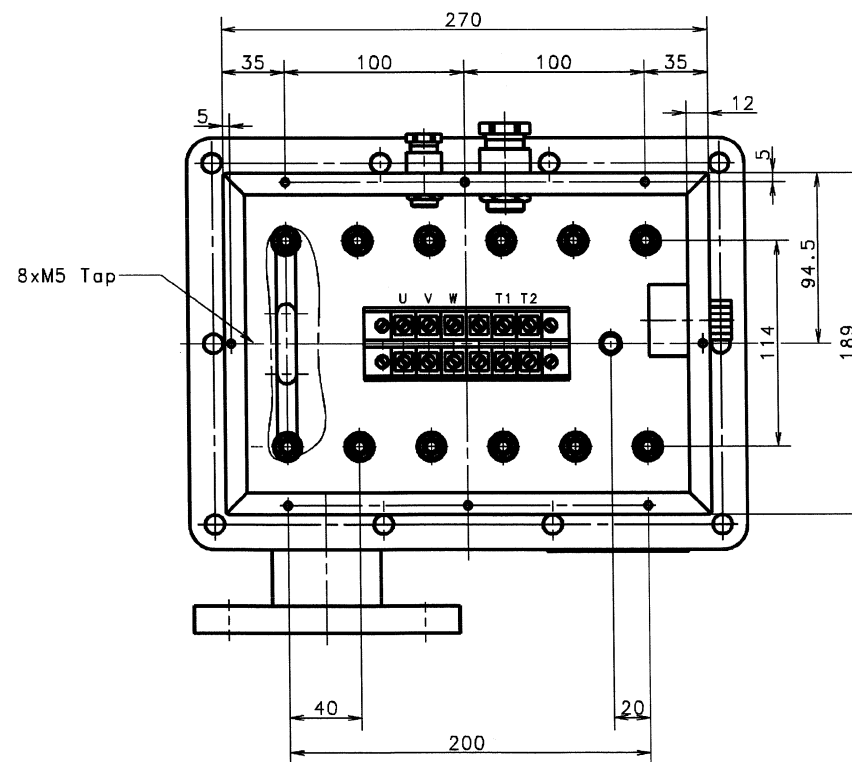
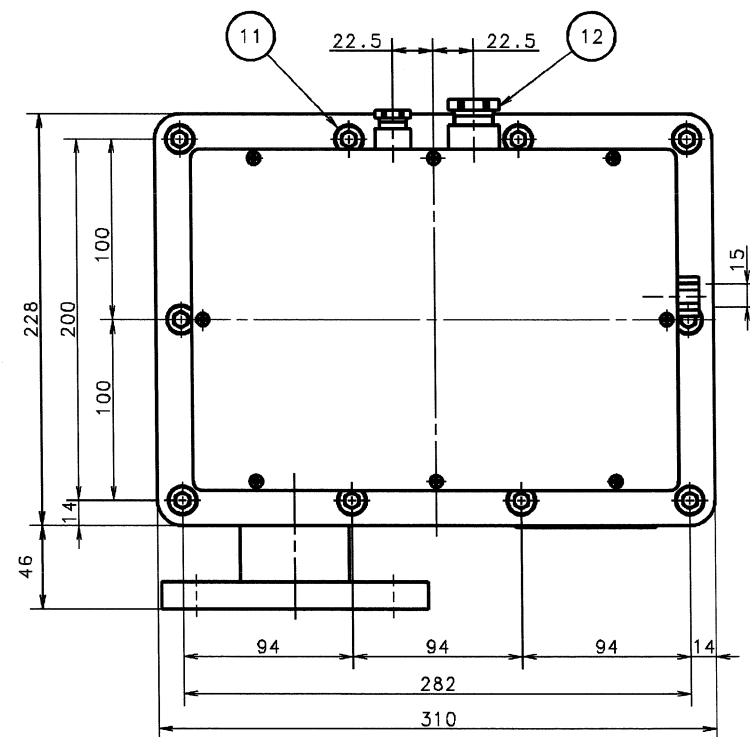
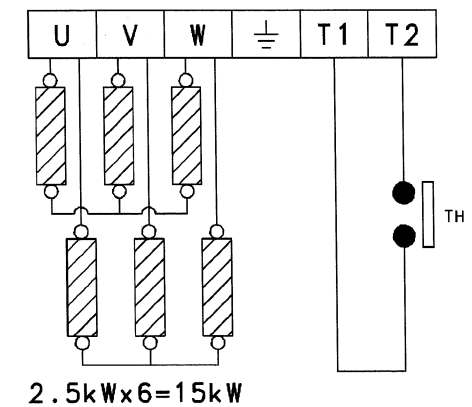
DETAIL FOR ELEMENTS(2:1)



Specification

1. Type : Electric
2. Medium : Fresh water
3. Test pressure : 0.75Mpa (7.5 bar)
Test time : Min.30 minute.
4. Working pressure : 0.5 Mpa (5 bar)
5. Max. working temp. : Max. 100°C
6. Temp.Control Range : 10°C-90°C
7. Temp.Control setting : 70°C
8. Protection class : IP44
9. Steel part의 용접은 algon용접으로 할것.
10. Heating tube는 magnesia를 성형후 silicon으로 몰름 할것.

CONNECTION DIAGRAM



12	-	Cable gland JISB 20C	-	1	-	-
11	-	Cable gland JISB 15C	TBAAF2100	1	-	-
10	-	Gasket 250 x 157 x 1.5t	TBAAF2100	1	-	-
09	-	Gasket 310 x 214 x 1.5t	TBAAF2100	1	-	-
08	JISB1101	Machine screw M5	SWRH62A	12	0.02	-
07	JISB1176	Socket head bolt M10 x 35	SCM435A	10	0.05	-
06	-	Thermostat with sensor	-	1	0.20	-
05	-	Terminal 60Ax6P	-	1	0.20	-
04	-	Terminal cover	SS400	1	0.60	-
03	-	Element tube Ø11x1.2t	SUS316	6	1.05	-
02	-	Terminal housing	SS400	1	7.52	-
01	B93-009952-5.1	Heater housing	SS400	1	15.6	-
POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
Supplement Drawing No. 130.77						
B11-121586-9.8 P82						
Date	Dev.	Chk.	Appd.	A.C.	E	C.No
						9
						8
						7
						6
						5
						4
						3
						2
						1
						0
051121DYJJCMSJR	*	*	*	*	*	Changed temp control range(93°C→90°C)
050618DYJJCMSJR	*	*	*	*	*	Changed no.01 heater housing & Specification
040910DYJJCMJCM	*	*	*	*	*	Changed design.
040823DYJJCMJCM	*	*	*	*	*	

This drawing, together with its supplements, is the property of HHI-EMD and subject to copyright protection. The material is placed at the disposal of the recipient solely for his own use, and only for the manufacture, repair or use of original HHI-EMD products, according to contract or other written agreement hereon with HHI-EMD. The material must not, either wholly or partly, be copied, reproduced, made public or in any other way made available to any third party without the written consent to this effect from HHI-EMD. The material must not be transferred or handed over to any third party, neither direct nor by succession to the rights of the recipient. 이 도면은 현대중공업의 재산이므로 당사 승인이 없이 이 도면을 제3자에게 양도, 복사, 판매, 허가, 이도면의해 부분을 제작하여 제3자에게 판매하는 것은 불법입니다.

Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1302-1978.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Tolerance for dimensions without tolerance indication(ISO 2768-1985)												
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining												
Non-measurement mm	0.5	over 0.5	over 30	over 120	over 315	over 1000						
Permissible deviations	up to 5	up to 30	up to 120	up to 315	up to 1000	up to 2000	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2
Medium series												

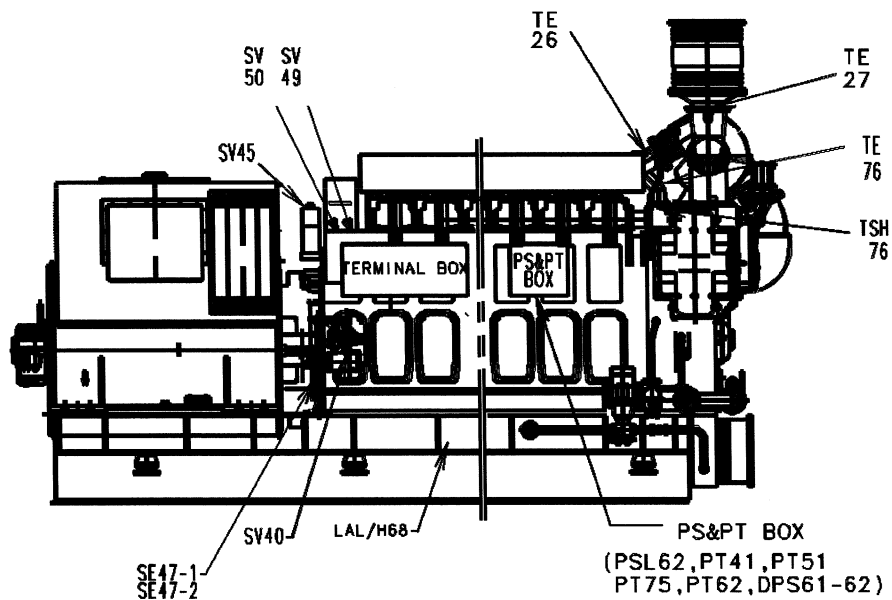
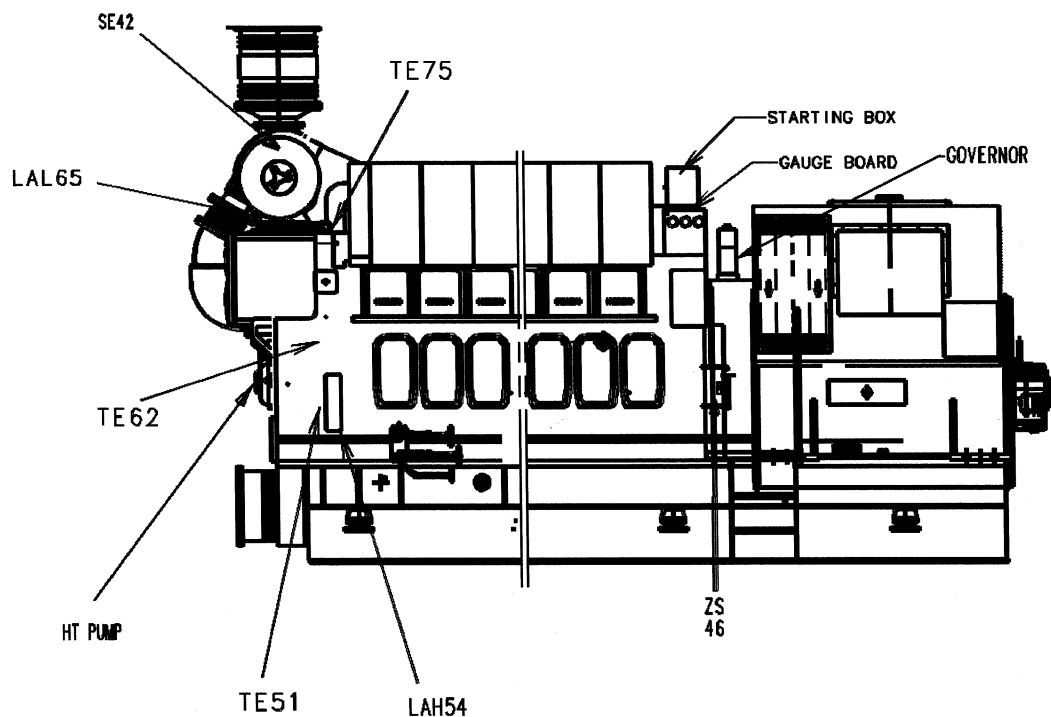
Scale	1:2	A1	Type	H21/32, H25/33	Page No.	01 (01)
Info. No.	135989	Description	Electric pre-heater ass'y	Ident. No.	B91-009930-0	
HSEF-K210-010(R1)						
현대중공업 (주) 연안사업본부						
A1 (84mmx594mm)1988						

PLAN HISTORY	ENGINE	HYUNDAI-HIMSEN
	TYPE	3x5H21/32x900rpm
	MESSRS	Yangfan Group Co.,Ltd
	RULE	ABS
	PROJECT	Yangfan2003~2008
	ENG. NO.	BA2768-2773

TITLE : SENSOR LIST & ELECTRIC CONNECTION DIAGRAM

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090827	JHK	KSJ	KSR	*	Changed Hull No.	1
071212	JHK	JCM	SJR	*	Replacement for Ident.no.:	0
Licensor Ident.no.:		Type:				
		5H21/32				
Info.no.:		Description:				
000000		SENSOR LIST&ELEC.CONN.DIAGRAM				
Page.no.:		Ident.no.:				
01 OF 04		B94-018701-6				





Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090827	JHK	KSJ	KSR	*	Changed Hull No.	1
071212	JHK	JCM	SJR	*	Replacement for Ident.no.:	0
Licensor Ident.no.:		Type: 5H21/32				
Info.no.: 000000		Description: ELECTRIC PARTS ARRANGMENT				
Page.no.: 02 OF 04		Ident.no.: B94-018701-6				

1. SAFETY SENSOR FOR ENGINE SHUTDOWN

CODE	DESCRIPTION	Q'TY/ ENG.	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY	DRAWING NO.
PSL 62	PRESS. SWITCH FOR LUB. OIL INLET	1SET	1-10kg/cm ²	3.0kg/cm ²	N.O CONTACT	0sec	B99-007888-0.0
TSH 76	TEMP. SWITCH FOR C.F.W OUTLET	1SET	20-150 °C	95 °C	N.O CONTACT	0sec	B12-129537-2.0
SSH 47-1	CONTROL PICK-UP FOR ENGINE RPM	1SET	0-1200RPM	1035RPM	N.O CONTACT	0sec	B13-141987-4.2
SSH 47-2	SAFETY PICK-UP FOR ENGINE RPM	1SET	0-1200RPM	1017RPM	N.O CONTACT	0sec	B13-141987-4.2
SE 42	PICK-UP FOR TURBOCHARGER RPM	1SET	0-60000RPM	ONLY INDICATION			T/C MAKER

2. SWITCH SENSOR FOR ALARM

CODE	DESCRIPTION	Q'TY/ ENG.	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY	DRAWING NO.
LAL/H 68	LEVEL SWITCH FOR L.O SUMP TANK	1SET	-	-	N.C CONTACT	30sec	B92-018946-6.3
LAH 54	LEVEL SWITCH FOR F.O LEAKAGE TANK	1SET	-	-	N.C CONTACT	0sec	B13-133238-1.3
LAL 65	LEVEL SWITCH FOR PRELUB. OIL INLET	1SET	-	-	N.C CONTACT	20sec	B93-002617-3.3
PDH61-62	DIFF. PRESS SWITCH FOR L.O FILTER	1SET	0.3-5kg/cm ²	1.5kg/cm ²	N.C CONTACT	10sec	B19-188944-3.0

NOTE

1) EACH SET POINT FOR SAFETY & SWITCH SENSOR IS CONFIGURED BY HHI-EMD

3. PRESSURE TRANSMITTER FOR ALARM/INDICATION

CODE	DESCRIPTION	Q'TY/ ENG.	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY	DRAWING NO.
PT 51	PRESSURE TRANSMITTER FOR FUEL OIL INLET	1SET	0-16kg/cm ²	HFO:6.0kg/cm ² MDO:1.0kg/cm ²	4~20mA	3sec	B99-007880-6.0
PT 62	PRESSURE TRANSMITTER FOR LUB. OIL INLET	1SET	0-10kg/cm ²	3.5kg/cm ²	4~20mA	3sec	B99-007879-7.0
PT 75	PRESSURE TRANSMITTER FOR H.T WATER INLET	1SET	0-6kg/cm ²	0.4+STATIC kg/cm ²	4~20mA	3sec	B99-007878-5.0
PT 41	PRESSURE TRANSMITTER FOR COMPRESSED AIR INLET	1SET	0-16kg/cm ²	4.5kg/cm ²	4~20mA	10sec	B99-007880-6.0

NOTE

2) ALARM SETTING VALUE FOR PT75 TO BE ADJUSTABLE DEPENDING ON 0.4 + STATIC kg/cm² PRESSURE BY SHIPYARD.

3) ALARM SETTING VALUE FOR PT51 IS (HFO: 6.0kg/cm² MDO: 1.0kg/cm²)

4) TIME DELAY & SET POINT ARE CONFIGURED BY YARD ON SHIP'S ALARM MONITORING SYSTEM

Date	Des.	Chk.	Appd.	A.G	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090827	JHK	KSJ	KSR	*	Changed Hull No.	1
071212	JHK	JCM	SJR	*	Replacement for Ident.no.:	0
Licensor Ident.no.:		Type:		5H21/32		
Info.no.:		Description:		SENSOR LIST FOR D/G ENGINE		
Page.no.:		03 OF 04		Ident.no.:		
						B94-018701-6

4. TEMPERATURE SENSOR FOR ALARM/INDICATION

CODE	DESCRIPTION	Q'TY/ ENG.	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY	DRAWING NO.
TE 75	TEMPERATURE TRANSMITTER FOR H.T WATER INLET	1SET	0-200°C	FOR INDICATION	Pt100	-	B99-001363-6.1
TE 51	TEMPERATURE TRANSMITTER FOR FUEL OIL INLET	1SET	0-200°C	FOR INDICATION	Pt100	-	B99-001363-6.1
TE 62	TEMPERATURE TRANSMITTER FOR LUB. OIL INLET	1SET	0-200°C	80°C	Pt100	3sec	B99-001364-8.1
TE 76	TEMPERATURE TRANSMITTER FOR H.T WATER OUTLET	1SET	0-200°C	90°C	Pt100	3sec	B99-001364-8.1
TE 26	TEMPERATURE TRANSMITTER WITH AMPLIFIER FOR EXHAUST GAS T/C INLET	2SET	0-600°C	580°C	4~20mA	3sec	B99-007299-0.1
TE 27	TEMPERATURE TRANSMITTER WITH AMPLIFIER FOR EXHAUST GAS T/C OUTLET	1SET	0-600°C	450°C	4~20mA	3sec	B99-007302-3.1

NOTE

5) TIME DELAY & SET POINT ARE CONFIGURED BY YARD ON SHIP'S ALARM MONITORING SYST

5. ELECTRIC EQUIPMENT

CODE	DESCRIPTION	Q'TY/ ENG.	INPUT VOLTAGE	CURRENT	POWER CONSUMPTION	DRAWING NO.
SV 50	FUEL LIMITER SOLENOID VALVE	1SET	24VDC	-	14W	B93-010027-7.0
SV 40	AIR STARTING SOLENOID VALVE	1SET	24VDC	-	6W	B92-000440-0.0
SV 49	EMERGENCY STOP SOLENOID VALVE	1SET	24VDC	-	14W	B93-010027-7.0
-	PRELUB. OIL PUMP	1SET	440VACx3Ph 60Hz	FULL LOAD:1.61A START:9.34A	0.81kW	B12-132876-3.5
GOV	UG-25+ WOODWARD GOVERNOR	1SET	24VDC	-	MAX. 27W	B99-010663-9.0
SI42/47	STARTING BOX WITH TACHO-METER	1SET	24VDC	-	5.4W	B94-007911-4.0
ZS46	LIMIT SWITCH FOR TURNING DEVICE	1SET	24VDC	0.4A	-	B93-002351-0.2

Date	Des.	Chk.	Appd.	A.G	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090827	JHK	KSJ	KSR	*	Changed Hull No.	1
071212	JHK	JCMS	JR	*	Replacement for Ident.no.:	0
Licensor Ident.no.:		Type:			5H21/32	
Info.no.:		Description:			SENSOR LIST FOR D/G ENGINE	
Page.no.:		04 OF 04			Ident.no.:	
						B94-018701-6

H.T. WATER OUTLET
HIGH TEMP. STOP



FFCS 2x0.75 SQ

53
54

FUEL LEAKAGE DRAIN BOX
HIGH LEVEL ALARM



FFCS 2x0.75 SQ

55
56

PRELUB. OIL INLET
LOW LEVEL ALARM
(CLOSE AT NORMAL)
(D.TIME SET : 20 s)



FFCS 2x0.75 SQ

57
58

LUB. OIL SUMP TANK
LOW/HIGH LEVEL ALARM
(D.TIME SET : 30 s)



COMMON

LOW

HIGH

FFCS 3x0.75 SQ

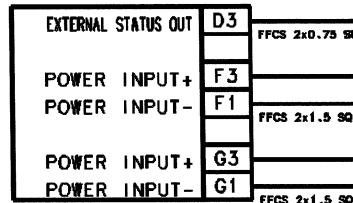
59
60
61

TURNING DEVICE ALARM
AND START BLOCKING



FFCS 2x0.75 SQ

62
63



64
65
66
67
68

H.T. WATER SYSTEM OUTLET
HIGH TEMP. ALARM



FFCS 3x0.75 SQ

69
70
71
72

LUB. OIL INLET
HIGH TEMP. ALARM



FFCS 3x0.75 SQ

73
74
75
76

FUEL OIL INLET
HIGH TEMP. ALARM



FFCS 3x0.75 SQ

77
78
79
80

H.T. WATER SYHSTEM INLET
HIGH TEMP. ALARM



FFCS 3x0.75 SQ

81
82
83
84

EXHAUST GAS T/C INLET
HIGH TEMP. ALARM



AMP

85
86

EXHAUST GAS T/C INLET
HIGH TEMP. ALARM



AMP

87
88

EXHAUST GAS T/C OUTLET



AMP

89
90
91
92
93
94
95

"*" MARKED CABLE IS SUPPLIED BY MAKER OF THE STARING BOX
& PS+PT BOX.

"**" MARK PLICA TUBE IS TO BE DONE BY OUR SHOP ENGINEER.

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
				*		1
				*		0
071212 JHK JCM S JR						
Licensor Ident.no.:					Type:	
					5H21/32	
Info.no.:					Description:	
000000					ENG.SIDE TERMINAL ARR'T	
Page.no.:					Ident.no.:	
02 OF 02					B94-018702-8	

HYUNDAI
HEAVY INDUSTRIES CO., LTD.

PLAN HISTORY		ENGINE TYPE	HYUNDAI - HiMSEN 3x5H21/32x900rpm			
△ 1	MESSRS.	Yangfan Group Co.,Ltd				
	RULE	ABS				
	PROJECT	Yangfan 2003~2008				
	ENG. NO.	BA2768~2773				
TITLE : D/G LOCAL CONTROL PANEL WIHT L.O PRIM PUMP STARTER AND J.W PREHEATER STARTER						
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:		Type:		5H21/32		
Info.no.:		Description:		COVER		
Page.no.: 01 OF 58				Ident.no.: B94-029865-7		

FUNCTION DESCRIPTION

1. Ready to Start Condition

- 1-1. Turning bar disengage
- 1-2. Not Engine Stop Condition.
- 1-3. Not Prelub. Oil Low Level(Prelub. Oil Pump is Running)
- 1-4. Engine Stationary
- 1-5. Not Blocking Push-Button Signal.
- 1-6. Not Tacho Fail Signal.

2. START

- 2-1. ON. Engine-Local-Remote Position S/W Selection
 - ON. Engine ; ON Engine Start Push-Button ON
 - Local Position ; Local Start Push-Button ON
 - Remote Position ; Remote Start Signal ON
- 2-2. When the Ready to Start is activated, the Engine can be started.

3. STOP

- 3-1. On Engine-Local-Remote Position Selection
 - On Engine ; On Engine Stop Push-Button ON - Set to On Engine Position
 - Local Position ; Local Stop Push-Button ON - Set to Local Position
 - Remote Position ; Remote Stop Signal ON - Set to Remote Position
- 3-3. Start Fail Condition(Auto. Stop)
- 3-4. Common Trip Condition (Overspeed, L.O low press., C.F.W high temp., Speed Sensor Fail. and Manual em'cy stop)

4. BLOCKING

- 4-1. Engine Start blocking

5. SHUTDOWN

- 5-1. Overspeed trip.(above rating speed 113%~115%)
- 5-2. L.O low press. trip.
- 5-3. C.F.W Outlet high temp. trip
- 5-4. Speed Sensor fail trip(if both control and safety pick-up are failed)
- 5-5. Manual em'cy stop(On eng./Local/Remote)

6. RESET

- 6-1. Shutdown Release(Trip Reset)
(It can be accessed at engine stand-still condition)

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type: 5H21/32		
Info.no.:				Description: FUNCTION DESCRIPTION		
Page.no.: 02 OF 58				Ident.no.: B94-029865-7		

7. CABLE SUPERVISION(Cable Cutting Detection)

- 7-1. Cable Detection For Em'cy Stop Sol. V/V
- 7-2. Cable Detection For Overspeed Trip Relay
- 7-3. Cable Detection For L.O low press. S/W
- 7-4. Cable Detection For C.F.W high temp. S/W

8. ALARM BLOCKING

The Local Control Panel is provided with a relay output for alarm blocking, so that ALARM is avoided during starting and stopping of the engines.

9. START FAIL

After Engine start button is ON, if engine is not running during time 15 s, the start fail signal is activated to engine stop. and start fail Lamp is ON.

— NOTE —

After the completion of panel production, the Test shall be carried out based on the Check List(Drawing No.: B94-011479-0.0). And the Test Reports shall be submitted with equipment.

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0

Licensor Ident.no.:		Type:	5H21/32	
Info.no.:		Description:	FUNCTION DESCRIPTION	
Page.no.: 03 OF 58				
				Ident.no.: B94-029865-7

GENERAL SPECIFICATION

1. CLASS & RULE : ABS

2. AMBIENT TEMP. : 45°C

3. CONSTRUCTION OF PANEL

-MOUNTING METHOD : WALL & DECK MOUNTING

-MATERIAL : SS400, 2.3t

-PAINT COLOR : RAL 7032

-PROTECTION DEGREE OF PANEL : IP23

-MAINTENANCE SPACE : FRONT SIDE

4. NAME PLATE

- LETTER : ENGLISH

- MATERIAL : PHENOLIC

5. ELECTRIC SOURCE/ SHIP

- AC220V, 1PH, 60Hz x 1FEEDER

- AC440V, 3PH, 60Hz x 3FEEDERS

(FOR AC440V, THE MINIMUM ONE FEEDER MUST BE CONNECTED FROM EMERGENCY POWER)

- DC24V x 1FEEDER (FROM EMERGENCY BATTERY POWER)

6. CABLE (INTERNAL)

- POWER CIRCUIT : 660V, SYP-2.0mm²~5.5mm²

- CONTROL CIRCUIT : 660V, SYP-0.75 ~1.25mm²
FLAME RETARDANT TYPE

7. DISTINGUISH BETWEEN COLOR OF CABLE LUG CAP

-D.C POWER CIRCUIT : P (RED), N(BLUE)

-A.C POWER CIRCUIT : R-U(RED), S-V(WHITE), T-W(BLACK)

-CONTROL CIRCUIT : WHITE WITH NUMBERING

8. SCOPE OF SUPPLY : 1SET/SHIP

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
				*		1
090828	JHK	KSJ	KSR	*	Change hull no.	0
071212	JHK	JCM	SJR	*		
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	GENERAL SPECIFICATION	
Page.no.: 04 OF 58						
						Ident.no.: B94-029865-7

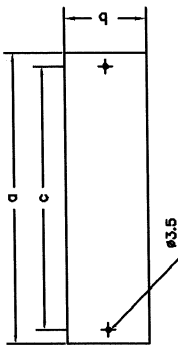
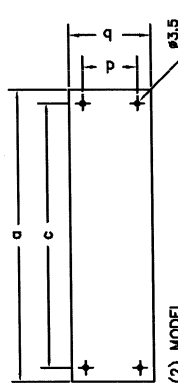
GRAPHICAL SYMBOLS

SYMBOL	NAME	SYMBOL	NAME
	RESISTOR		MAKE CONTACT(NORMAL OPEN)
	RESISTOR WITH TAPPING		BREAK CONTACT(NORMAL CLOSE)
	WINDING, INDUCTOR		CHANGE-OVER CONTACT
	WINDING, INDUCTOR TAPPING		CHANGE-OVER CONTACT MAKE - BEFORE - BREAK
	CAPACITOR		MAKE CONTACT, (ON DELAY TIMER)
	POLARIZED CAPACITOR		BREAK CONTACT, (ON DELAY TIMER)
	BATTERY		MAKE CONTACT (OFF DELAY TIMER)
	EARTH(GROUND) CONNECTION		BREAK CONTACT (OFF DELAY TIMER)
	FRAME OR CHASIS CONNECTION		TRIPLE-POLE CIRCUIT BREAKER
	CONVERTER, TRANSMITTER		CIRCUIT BREAKER
	AMPLIFIER		SINGLE THROW SWITCH MANUALLY OPERATED
	SINGLE-PHASE BRIDGE- CONNECTED RECTIFIER		MOMENTARY SWITCH,MAKE CONTACT MANUALLY OPERATED
	THERMOCOUPLE		MOMENTARY SWITCH,BREAK CONTACT MANULLY OPERATED
	FUSE		MAINTAINED SWITCH,MAKE CONTACT MANUALLY OPERATED
	PLUG & SOCKET DEVICE		MAINTAINED SWITCH,BREAK CONTACT MANUALLY OPERATED
	VALVE		KEY OPERATED SWITCH,MAKE CONTACT
	CONTACTORS, RELAYS		KEY OPERATED SWITCH,BREAK CONTACT
	TIME RELAY (OFF DELAY)		SEMICONDUCTOR DIODE
	(SIG.ON : INSTANTANEOUS OPERATED) (SIG.OFF : DELAY OPERATED)		TRANSFORMER WITH TWO SEPARATE WINDING
	TIME RELAY (ON DELAY)		HORN
	(POWER ON : DELAY OPERATED) (POWER OFF : INSTANTANEOUS)		BELL
	TIME RELAY (FLICKERING OPERATED SIG.)		BUZZER
	PILOT LIGHT INDICATING LIGHT		
	SIREN		

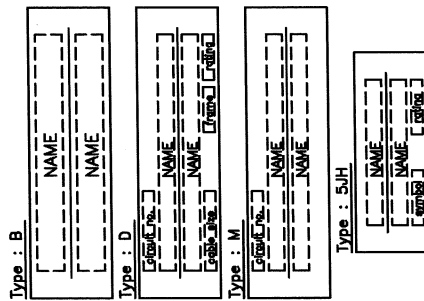
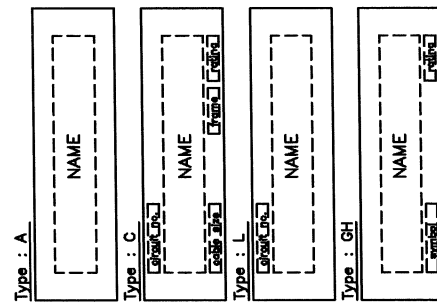
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type: 5H21/32		
Info.no.:				Description: SYMBOL LIST		
Page.no.: 05 OF 58				Ident.No.: B94-029865-7		

NAME PLATE FOR SQUARE LAMP

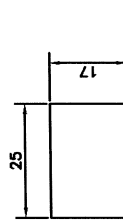
(1) SIZE



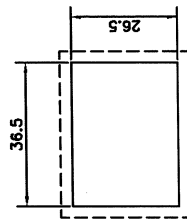
(2) MODEL



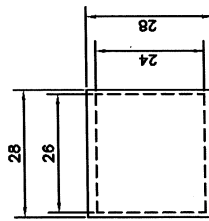
TYPE : RLC
MATERIAL : MAKER SUPPLY
LETTER : BLACK
(EAO LAMP TYPE 02 SERIES)



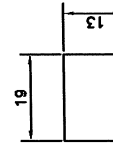
TYPE : RLA
MATERIAL : METHACRYLATE
THICKNESS : 1.0mm
LETTER : BLACK
GROUND : WHITE
(YONG SUNG LAMP TYPE YSNRL34)



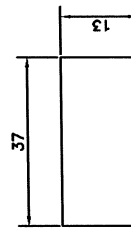
TYPE : LN2
MATERIAL : METHACRYLATE
THICKNESS : 1.5mm
GROUND : WHITE
(KUN HUNG LAMP TYPE KH500TL)



TYPE : RLD
MATERIAL : FILM
LETTER : BLACK
(EAO LAMP TYPE 31 SERIES)



TYPE : RLE
(EAO LAMP TYPE 03 SERIES)



1. MATERIAL : PHENOLIC
2. GROUND : WHITE
3. LETTER : BLACK (Rating : RED)
4. "AH", "B", "JH" Type : adhesive Type
5. t : DEPTH (THICKNESS)

Type : CL

1. material : phenolic
2. letter : black



Type : CL1

1. material : phenolic
2. letter : black



(3) LETTERS EXAMPLE

Circuit no.: G1, M19A, GCP2
Cable size : H-TPYC-80
Frame : 60, 100, 225, 250, 400, 1800
Rating : 15A, 400A, INST1000A

Type	a	b	c	d	t
0	315	63	302	50	3
01	400	63	387	50	3
1	46	10	36	-	2
2	50	12.5	40	-	2
3	50	20	40	-	2
4	63	16	53	-	2
5	63	25	53	-	2

NOTE

SAMHO PJT(SH0000) NAME PLATE MATERIAL : SUS-316
OTHER PJT NAME PLATE MATERIAL : PHENOLIC

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type: 5H21/32		
Info.no.:				Description: NAME PLATE MODEL		
Page.no.: 06 OF 58				Ident.no.: B94-029865-7		

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:		
Info.no.:				5H21/32		
Page.no.: 07 OF 58				Description:		
				TANSFER SWITCHES LIST		Ident.no.: B94-029865-7

NO.	SYMBOL	NAME	TYPE	SPEC.	REMARK	Q'TY	MAKER
1	1~3Q1	M.C.B	C60N-2P	63AF/16AT	24660	3	MERLIN GERIN
2	1~3Q4,5	M.C.B	C60N-2P	63AF/6AT		6	MERLIN GERIN
3	1FA,FB	FUSE & HOLDER	SB-C1	20A		2	SB FUSE
4	1F11~16	FUSE & HOLDER	SB-C1	5A		6	SB FUSE
5	1F21~26	FUSE & HOLDER	SB-C1	5A		6	SB FUSE
6	1F31~36	FUSE & HOLDER	SB-C1	5A		6	SB FUSE
7	1F17~37 1F18~38 1FC1,FC2	FUSE & HOLDER	SB-C1	3A		8	SB FUSE
8	1FC3,FC4	FUSE & HOLDER	SB-C1	5A		2	SB FUSE
9	1FE,FF	FUSE & HOLDER	SB-C1	25A		2	SB FUSE
10	1KD	RELAY W/HOLDER	G7J-4A-B	DC24V, 4a	R99-04 FOR G5F	1	OMRON
11	1~3K30~36	RELAY W/BASE	SZR-LY4-N1	DC24V, 4c		21	HONEYWELL
12	1~3K2,14	RELAY W/BASE	SZR-LY4-N1	DC24V, 4c		6	HONEYWELL
13	K1,2,4~6,6A KA~D 1~3K90,91,92	RELAY W/BASE	SZR-MY4-N1	DC24V, 4c		19	HONEYWELL
14	1~3K1,3~5 1~3K6A,7,7A	RELAY W/BASE	SZR-MY4-N1	DC24V, 4c		21	HONEYWELL
15	1~3K9~13,13A 1~3K15~18 1~3K20A,40	RELAY W/BASE	SZR-MY4-N1	DC24V, 4c		36	HONEYWELL
16	1~3K14A,22A 1~3K21~25	RELAY W/BASE	SZR-MY4-N1	DC24V, 4c		21	HONEYWELL
17	1~3K40A,41 1~3K2A,2B,43	RELAY W/BASE	SZR-MY4-N1	DC24V, 4c		15	HONEYWELL
18	1~3K45~50 1~3K51,53,56	RELAY W/BASE	SZR-MY4-N1	DC24V, 4c		27	HONEYWELL
19	KE,1~3K6,8 1~3K42,52	RELAY W/BASE	SZR-LY2-N1	DC24V, 2c		13	HONEYWELL
20	T2,1~3T1	TIMER W/BASE	H3BA-N	DC24V, 2c		4	OMRON
21	1~3T2	TIMER W/BASE	H3BA-8H	DC24V, 1c DC24V, 1INST		3	OMRON
22	T1 1~3T3~7	TIMER W/BASE	H3Y-4	DC24V, 4c	30 s	16	OMRON
23	1~3A6	CABLE SUPERVISION	CF-10DN	DC24V, 10POINT		3	YUMYUNG
24	1~3A1	SPEED MEASURING UNIT	SMP-7000H		FOR CONTROL	3	YUMYUNG
25	1~3A5	SPEED MEASURING UNIT	SMP-7000HS		FOR SAFETY	3	YUMYUNG
26	1~3A2	ANNUNCIATOR	ANN-15P	DC24V,15POINT		3	YUMYUNG
27	1~3A4	ALARM MONITORING	AM-15D	DC24V,15POINT		3	YUMYUNG

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type: 5H21/32		
Info.no.:				Description: PARTS LIST / SHIP		
Page.no.: 08 OF 58				Ident.no.: B94-029865-7		

NO.	SYMBOL	NAME	TYPE	SPEC.	REMARK	Q'TY	MAKER
28	1~3H2~5	IND. LAMP	YSBRL34-DL24-Y	DC24V, LED	YELLOW	12	YONG SUNG
29	1~3H1	IND. LAMP	YSBRL34-DL24-W	DC24V, LED	WHITE	3	YONG SUNG
	1~3H6	IND. LAMP	YSNRL34-DL24-G	DC24V, LED	GREEN	3	
30	1~3H7~24 HA,HB	IND. LAMP	YSNRL34-DL24-R	DC24V, LED	RED	56	YONG SUNG
31	1~3S1	PUSH BUTTON W/COVER	KH-2022	ø25,1a1b	GREEN	3	KUN HUNG
32	1~3S2	PUSH BUTTON W/COVER	KH-2022	ø25,1a1b	RED	3	KUN HUNG
33	1S3	PUSH BUTTON	YSP13-33B	ø30,3a3b	BLACK	1	YONG SUNG
34	1S4	PUSH BUTTON	YSP13-11B	ø30,1a1b	BLACK	1	YONG SUNG
35	1S5	PUSH BUTTON	YSP13-22B	ø30,2a2b	BLACK	1	YONG SUNG
36	1~3CS1	CAM SWITCH	SH-CSS-3301-2(M612)-SPS-BB-RHB			3	SAM WHA
37	1~3SH7	P.B. W/LAMP	704.060.2	RED	MAINTAINED	3	eao
38		LAMP	704.000.2	24V,50mA		3	eao
39		SWITCHING ELEMENT	704.900.3	2a		3	eao
40		PROTECTION COVER	704.925.0			3	eao
41	U1	POWER SUPPLY	JWS-60024	AC220V/DC24V	600W	1	LAMBDA
42	1VD1 1VF1,2	DIODE	DD40F80	40A, 800V	W/HEAT SINK	3	SANREX
43		DIODE BOARD		22POINT	(FOR 1N5408)	3	YUMYUNG
44		DIODE	1N5408	3A, 800V		64	
45		RESISTOR		10Kohm,1/2W		27	
46	1HB	ALARM BELL		DC24V		1	IL KWANG
47	1~3Q2	M.C.C.B	HBS33C	60AF/10AT		3	HYUNDAI
48	1~3K61	MAGNETIC CONTACTOR	HIMC22W11	AC220V		3	HYUNDAI
49		AUX. CONTACT BLK	HAB31	3a1b		3	HYUNDAI
50	1~3F61	E.O.C.R	EOCR-SS-05N-220-D	0.5~6A	AC220V	3	SAM WHA
51	TR11~31	TRANSFORMER	HCW-96,100VA	1ø,440/220,20V		3	H.K.T
52	1~3K62	RELAY W/BASE	SZR-MY4-N1	AC220V,4c		3	HONEYWELL
53	1~3K92	RELAY W/BASE	SZR-MY4-N1	DC24V,4c		3	HONEYWELL
54	1~3H40	PILOT LAMP	YSPL3-024AW	ø30,24V,1W	WHITE	3	YONG SUNG

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type: 5H21/32		
Info.no.:				Description: PARTS LIST / SHIP		
Page.no.: 09 OF 58				Ident.no.: B94-029865-7		

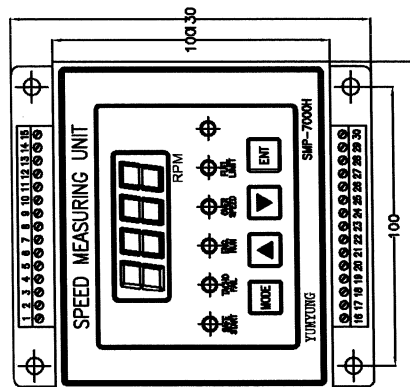
NO.	SYMBOL	NAME	TYPE	SPEC.	REMARK	Q'TY	MAKER
55	1~3H41 1~3S8	P.B W/LAMP	YSNPBL3-024AG	ø30,24V,1W,1a1b	GREEN	3	YONG SUNG
56	1~3S9	PUSH BUTTON	YSP13-11R	ø30,1a1b	RED	3	YONG SUNG
57	1~3CS2	SELECTOR S.W	YSR3-222KB	ø30,2a2b		3	YONG SUNG
58	1~3F1,2,4	FUSE & HOLDER	SB-C1	1A		9	SB FUSE
59	1~3F3,F5	FUSE & HOLDER	SB-C1	1A		6	SB FUSE
60	1VC1~3	DIODE	P600J	6A,600V		3	
61	1~3K55	KEEP RELAY W/BASE	MY2K	DC24V,2C		3	OMRON
62	1~3Q3	M.C.C.B	HBS63C	60AF/30AT		3	HYUNDAI
63	1~3K71	MAGNETIC CONTACTOR	HIMC32W22	AC220V		3	HYUNDAI
64	1~3F71	E.O.C.R	EOCR-SS-30N-220-D	5~30A	AC220V	3	SAM WHA
65	TR11~31	TRANSFORMER	HCW-96,100VA	1ø,440/220,20V		3	H.K.T
66	1~3K72	RELAY W/BASE	SZR-LY2-N1	AC220V,4c		3	HONEYWELL
67	1~3H50	PILOT LAMP	YSPL3-024AW	ø30,24V,1W	WHITE	3	YONG SUNG
68	1~3H51 1~3S10	P.B W/LAMP	YSNPBL3-024AG	ø30,24V,1W,1a1b	GREEN	3	YONG SUNG
69	1~3S11	PUSH BUTTON	YSP13-11R	ø30,1a1b	RED	3	YONG SUNG
70	1~3CS3	SELECTOR S.W	YSR3-222KB	ø30,1a1b		3	YONG SUNG
71							
72	1~3F6,7,9	FUSE & HOLDER	SB-C1	1A		9	SB FUSE
73	1~3F8,10	FUSE & HOLDER	SB-C1	1A		6	SB FUSE
74		TERMINAL BLOCK	DATN-60A	60A,14Sq		2	DONG A
75		TERMINAL BLOCK	DATN-35A	35A,5.5Sq	FOR DIODE VC(+6EA)	35	DONG A
76		TERMINAL BLOCK	STS 2.5 TWIN	15A,2Sq	FOR D/BOARD IN5408(+18EA)	452	PHOENIX CONTACT

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type: 5H21/32		
Info.no.:				Description: PARTS LIST / SHIP		
Page.no.: 10 OF 58				Ident.no.: B94-029865-7		

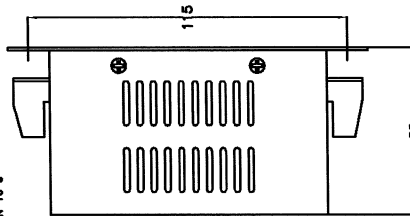
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	SPEED MEASURING UNIT FOR CONTROL CIRCUIT (SMP-7000H)	
Page.no.:						
11 OF 58						
					Ident.no.:	B94-029865-7

TYPE	SOFTWARE NO. FALL SOFTWARE FILTER	ENGINE TYPE	ENGINE RPM	(N 4~7) IMPULS PR. REVOLUTION	(IN 11) START	(OUT 18) TACHO FAL	(OUT 17) SAFE START RPM	(OUT 18) ENGINE RUN RPM	(OUT 19) OVERSPEED RPM	(OUT 20) FUEL LIMIT CONTROL ON RPM	(OUT 21) SPARE	(OUT 28~30) ENG.TACHOMETER	(OUT 25~27) TURBO CHARGER PRESSURE (INPUT 25~27)
SMP-7000H	SOFT.0	H21/32	720	288 IMP /REV	ON AT START	FAL OF PICK-UP	ON	OFF	828	25		1200 RPM, 0~8V	60000 RPM, 0~8V
SMP-7000H	SOFT.1	H21/32	750	288 IMP /REV	ON AT START	PICK-UP OK	0 RPM + 5 *	WHEN RPM<640	862	25		1200 RPM, 0~8V	60000 RPM, 0~8V
SMP-7000H	SOFT.2	H21/32	900	288 IMP /REV	ON AT START	PICK-UP OK	0 RPM + 5 *	WHEN RPM<640	1035	25		1200 RPM, 0~8V	60000 RPM, 0~8V
SMP-7000H	SOFT.3	H21/32	1000	288 IMP /REV	ON AT START	PICK-UP OK	0 RPM + 5 *	WHEN RPM<640	1150	25		1200 RPM, 0~8V	60000 RPM, 0~8V
SMP-7000H	SOFT.4	H25/33	720	282 IMP /REV	ON AT START	FAL OF PICK-UP	ON	OFF	828	25		1200 RPM, 0~8V	60000 RPM, 0~8V
SMP-7000H	SOFT.5	H25/33	750	282 IMP /REV	ON AT START	PICK-UP OK	0 RPM + 5 *	WHEN RPM<640	862	25		1200 RPM, 0~8V	60000 RPM, 0~8V
SMP-7000H	SOFT.6	H25/33	900	282 IMP /REV	ON AT START	PICK-UP OK	0 RPM + 5 *	WHEN RPM<640	1035	25		1200 RPM, 0~8V	60000 RPM, 0~8V
SMP-7000H	SOFT.7	H25/33	1000	282 IMP /REV	ON AT START	PICK-UP OK	0 RPM + 5 *	WHEN RPM<640	1150	25		1200 RPM, 0~8V	60000 RPM, 0~8V

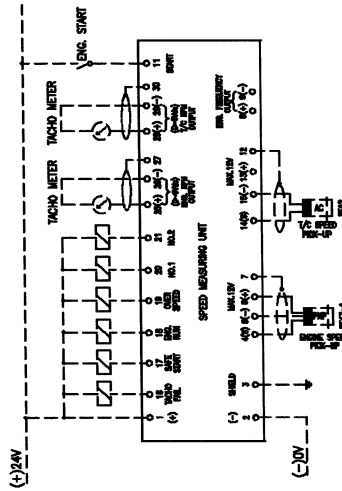
* AFTER 200RPM IF DETECTED
 RPM RISE, TACHO FAL
 * AFTER START ON 500RPM
 WITHIN 10 *



FRONT VIEW



SIDE VIEW



WIRING DIAGRAM

WALL MOUNT DIMENSION

GENERAL SPEC.

- MAKER : YUNKUNG ENG. CO.LTD.
 - MODEL : SMP-7000H
 - OPERATION TEMP. : -10 ~ 65°C
 - POWER SOURCE : DC24V ±20%
 - POWER CONSUMPTION : abt. 5Watt.
 - DISPLAY RANGE / INPUT
 - ENG. : 0~1200/0~104H(SQUARE WAVE, MAX.±12V)
 - T/C : NOT DISPLAY/0~2Hz (SINE WAVE, MAX.±15V)
 - DISPLAY : 4DIGITS, 7SEGMENT LED, 6 LEDS
 - ACCURACY : ±0.2% F.S.±1DIGIT
- OUTPUT
 - VOLTAGE OUTPUT
 - ENG. : 0 ~ 6VDC
 - T/C : 0 ~ 8VDC
 - FREQUENCY
 - ENG. : 0~10KHz (SQUARE WAVE, MAX. +12V)
 - DRY CONTACTS(6PCS)
 - FET DRIVER MAX. 100VDC 0.5A
 - WEIGHT : abt. 720g

TYPE	SOFTWARE NO. INCL. SOFTWARE FILTER	ENGINE		(IN 3-4) IMPUIS PR. REVOLUTION	(IN 12) START	(OUT 7) TACHO FAL.		(OUT 8) SAFE START RPM		(OUT 9) ENGINE RUN RPM		(OUT 10) OVERSPEED RPM
		TYPE	RPM			ON	OFF	ON	OFF	ON	OFF	
SMP-7000HS	SOFT.0	H21/32	720	288 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	710 OR 200+10 s	WHEN RPM<640	813
SMP-7000HS	SOFT.1	H21/32	750	288 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	710 OR 200+10 s	WHEN RPM<640	847
SMP-7000HS	SOFT.2	H21/32	900	288 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	880 OR 200+10 s	WHEN RPM<700	1017
SMP-7000HS	SOFT.3	H21/32	1000	288 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	930 OR 200+10 s	WHEN RPM<730	1130
SMP-7000HS	SOFT.4	H25/33	720	282 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	710 OR 200+10 s	WHEN RPM<640	813
SMP-7000HS	SOFT.5	H25/33	750	282 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	710 OR 200+10 s	WHEN RPM<640	847
SMP-7000HS	SOFT.6	H25/33	900	282 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	880 OR 200+10 s	WHEN RPM<700	1017
SMP-7000HS	SOFT.7	H25/33	1000	282 IMP /REV	ON AT START	FAL. OF PICK-UP	PICK-UP OK	0 RPM + 5 s	140 OR IN 12 OFF OR TACHO FAL.	930 OR 200+10 s	WHEN RPM<730	1130

☐ ☐ ☒ ☐ ☐ ☐ ☐ ☐

• AFTER >300RPM F DETECTED
 • OPEN IMMEDIATELY.
 • AFTER START ON-300RPM WITHIN 10 s

FRONT VIEW

SIDE VIEW

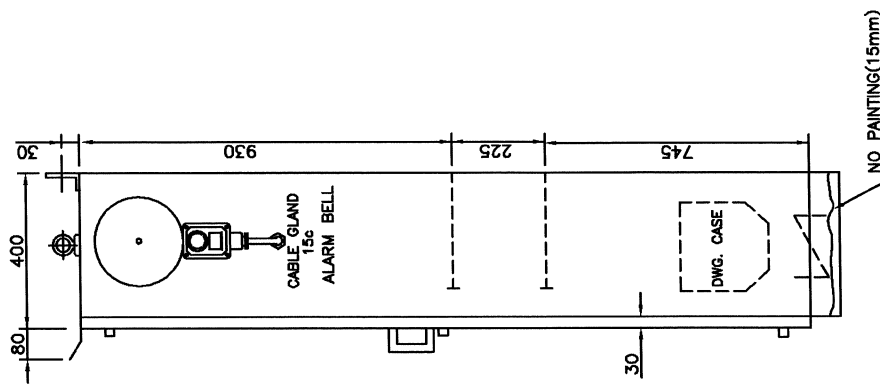
WIRING DIAGRAM

WALL MOUNT DIMENSION

GENERAL SPEC.

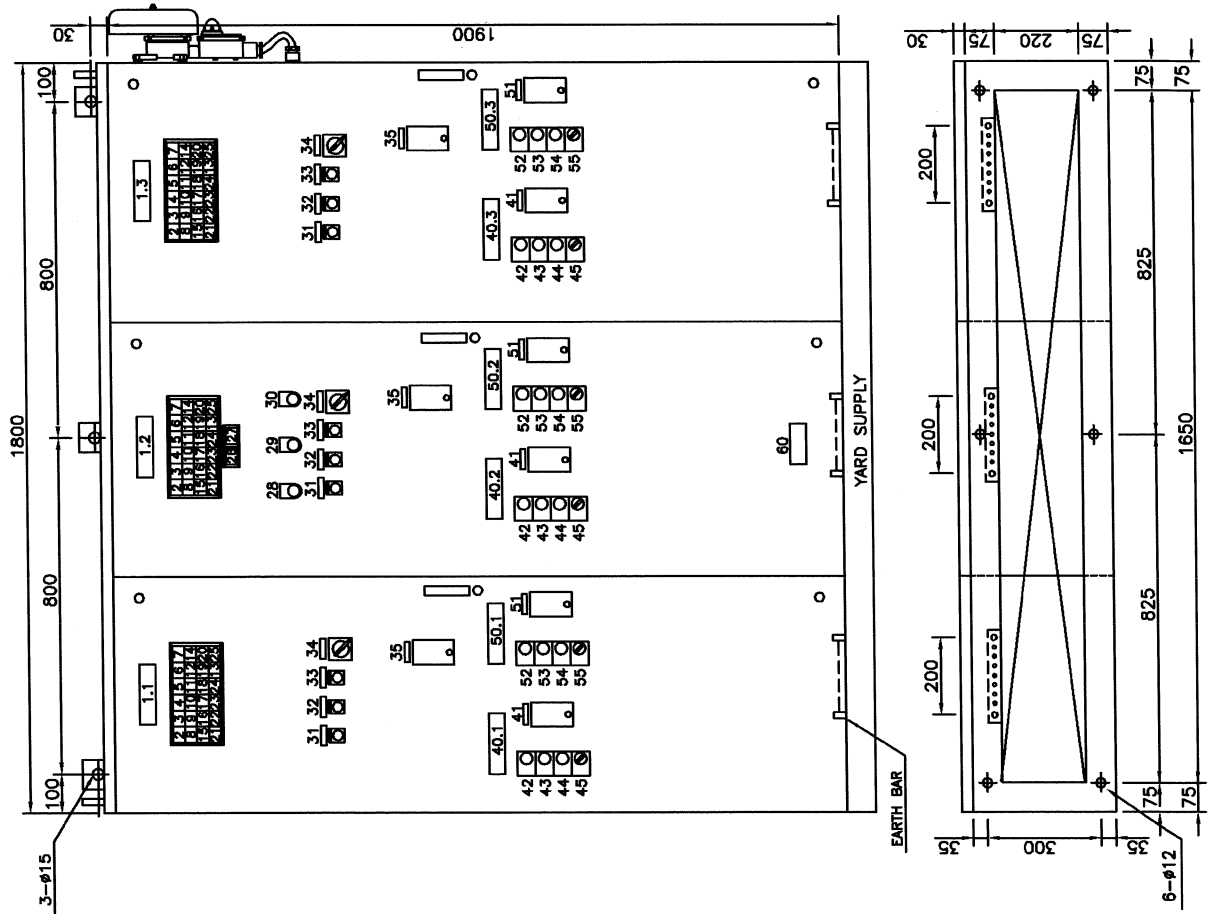
1. MAKER : YUMYUNG ENG. CO.,LTD.
2. MODEL : SMP-7000HS
3. OPERATION TEMP. : -10 ~ 65°C
4. POWER SOURCE : DC24V ±20%
5. POWER CONSUMPTION : abt. 2.4Watt.
6. INPUT
 - ENG. : 0 ~ 10KHz(SQUARE WAVE, MAX.+12V)
7. DISPLAY : 4 LEDS
8. ACCURACY : F.S.±0.2%
9. OUTPUT : DRY CONTACTS(4PCS)
 - FET DRIVER MAX. 100VDC 0.5A
10. WEIGHT : abt. 400g

Date	Des.	Chk.	Appl.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:		
Info.no.:				Description:		
Page.no.:				Ident.no.:		
12 OF 58				5H21/32		
				SPEED MEASURING UNIT FOR CONTROL CIRCUIT (SMP-7000HS)		
				B94-029865-7		



NOTE

1. PAINT COLOR : RAL 7032 (HAMMERTONE & EMBOSING TYPE)
2. ENCLOSURE PROTECTION : IP23
3. MATERIAL : SS400, 2.3t
4. WALL & DECK MOUNTING TYPE
5. WEIGHT : dbt. 800kg/PANEL
6. CABLE INLET SPACE
7. POWER CONSUMPTION : DC24V MAX. 600W AC220V MAX. 1600VA

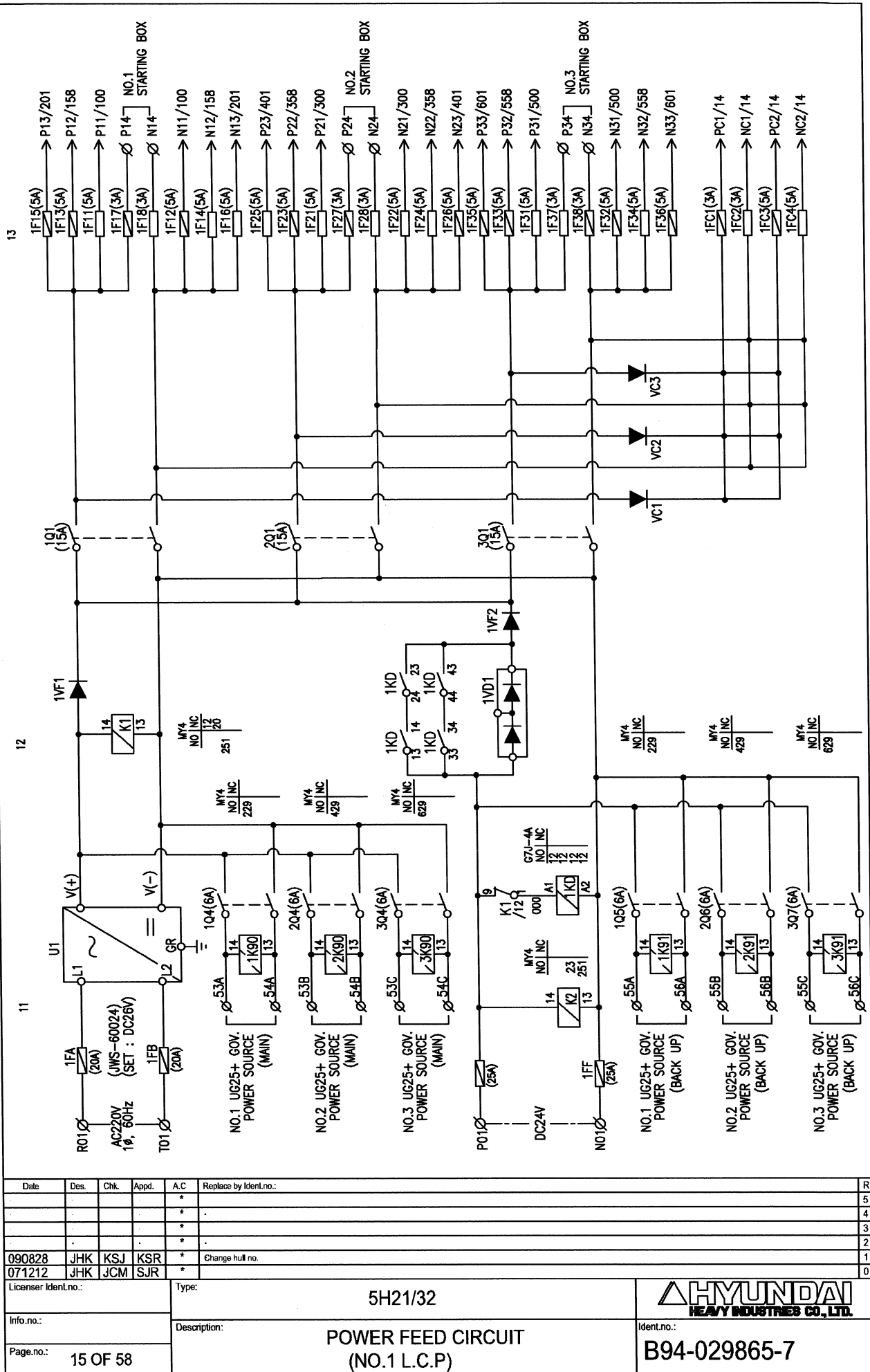


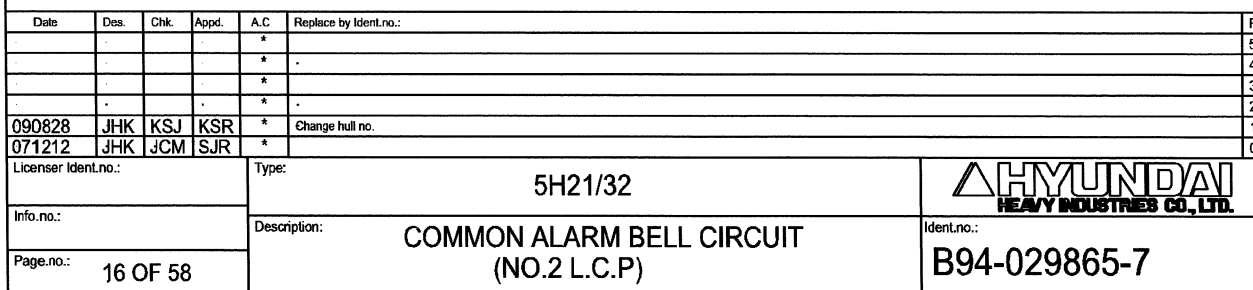
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	OUTLINE VIEW OF D/G LOCAL CONTROL PANEL	
Page.no.: 13 OF 58						
						Ident.no.: B94-029865-7

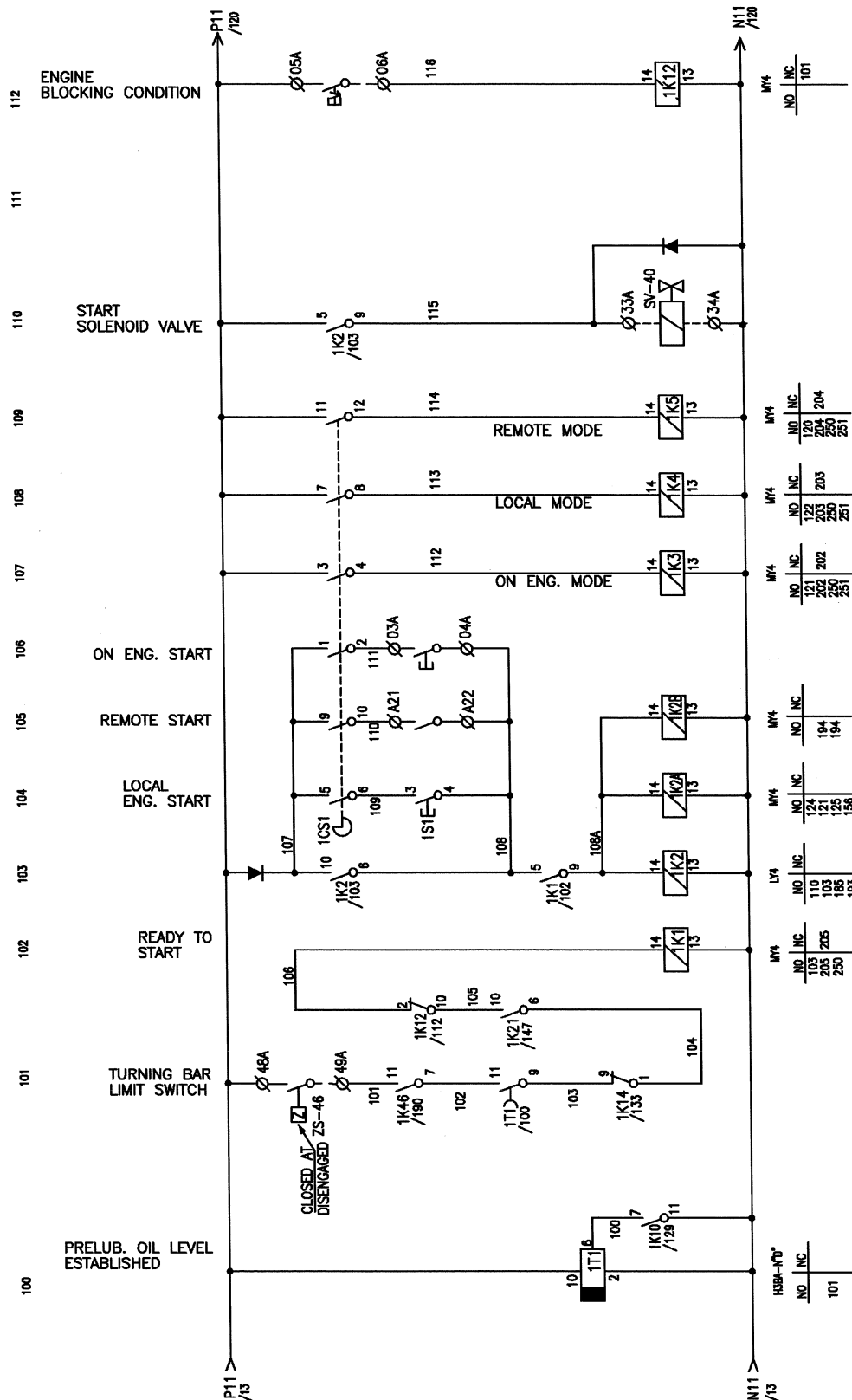
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:		Type:				
		5H21/32				
Info.no.:		Description:				
		NAME PLATE LIST FOR D/G LOCAL CONTROL PANEL				
Page.no.:		Ident.no.:				
14 OF 58		B94-029865-7				

NO. SYMBOL	DESCRIPTION	NAME PLATE MARK	TYPE	QTY	REMARKS
1.1	NAME PLATE	NO.1 D/G CONTROL PANEL	8A	1	
1.2	NAME PLATE	NO.2 D/G CONTROL PANEL	8A	1	
1.3	NAME PLATE	NO.3 D/G CONTROL PANEL	8A	1	
2	LAMP(WHITE)	CONTROL SOURCE ON	RLA	3	LED
3	LAMP(YELLOW)	ON ENGINE CONTROL	RLA	3	LED
4	LAMP(YELLOW)	LOCAL CONTROL	RLA	3	LED
5	LAMP(YELLOW)	REMOTE CONTROL	RLA	3	LED
6	LAMP(YELLOW)	READY TO START	RLA	3	LED
7	LAMP(GREEN)	RUNNING	RLA	3	LED
8	LAMP(RED)	STOPPING	RLA	3	LED
9	LAMP(RED)	OVER SPEED TRIP	RLA	3	LED
10	LAMP(RED)	L.O LOW PRESS. TRIP	RLA	3	LED
11	LAMP(RED)	C.F.W HIGH TEMP. TRIP	RLA	3	LED
12	LAMP(RED)	SPEED SENSOR FAIL TRIP	RLA	3	LED
13	LAMP(RED)	EM'CY STOP	RLA	3	LED
14	LAMP(RED)	START FAILURE	RLA	3	LED
15	LAMP(RED)	F.O LEAKAGE TANK HIGH LEVEL	RLA	3	LED
16	LAMP(RED)	TRIP CIRCUIT FAIL	RLA	3	LED
17	LAMP(RED)	PRELUB. OIL P/P STARTER FAIL	RLA	3	LED
18	LAMP(RED)	PRELUB. OIL INLET LOW LEVEL	RLA	3	LED
19	LAMP(RED)	L.O SUMP TANK LOW LEVEL	RLA	3	LED
20	LAMP(RED)	L.O SUMP TANK HIGH LEVEL	RLA	3	LED
21	LAMP(RED)	L.O FILTER DIFF. PRESS. HIGH	RLA	3	LED
22	LAMP(RED)	TACHO FAILURE	RLA	3	LED
23	LAMP(RED)	GOV. FAILURE	RLA	3	LED
24	LAMP(RED)	SPARE	RLA	3	LED
25	LAMP(RED)	SPARE	RLA	3	LED
26	HA	AC SOURCE FAIL	RLA	1	LED
27	HB	DC SOURCE FAIL	RLA	1	LED
28	1S5	LAMP & BELL TEST	CL	1	
29	1S4	ACKNOWLEDGE	CL	1	
30	1S3	TRIP RESET	CL	1	
31	1~3SH7	EM'CY STOP	2A	3	W/COVER
32	1~3S1	START	2A	3	W/COVER
33	1~3S2	STOP	2A	3	W/COVER
34	1~3CS1	CONTROL POSITION ON ENG - LOCAL -REMOTE	2A	3	
35	1~3G1	SOURCE(OC 24V)	2A	3	

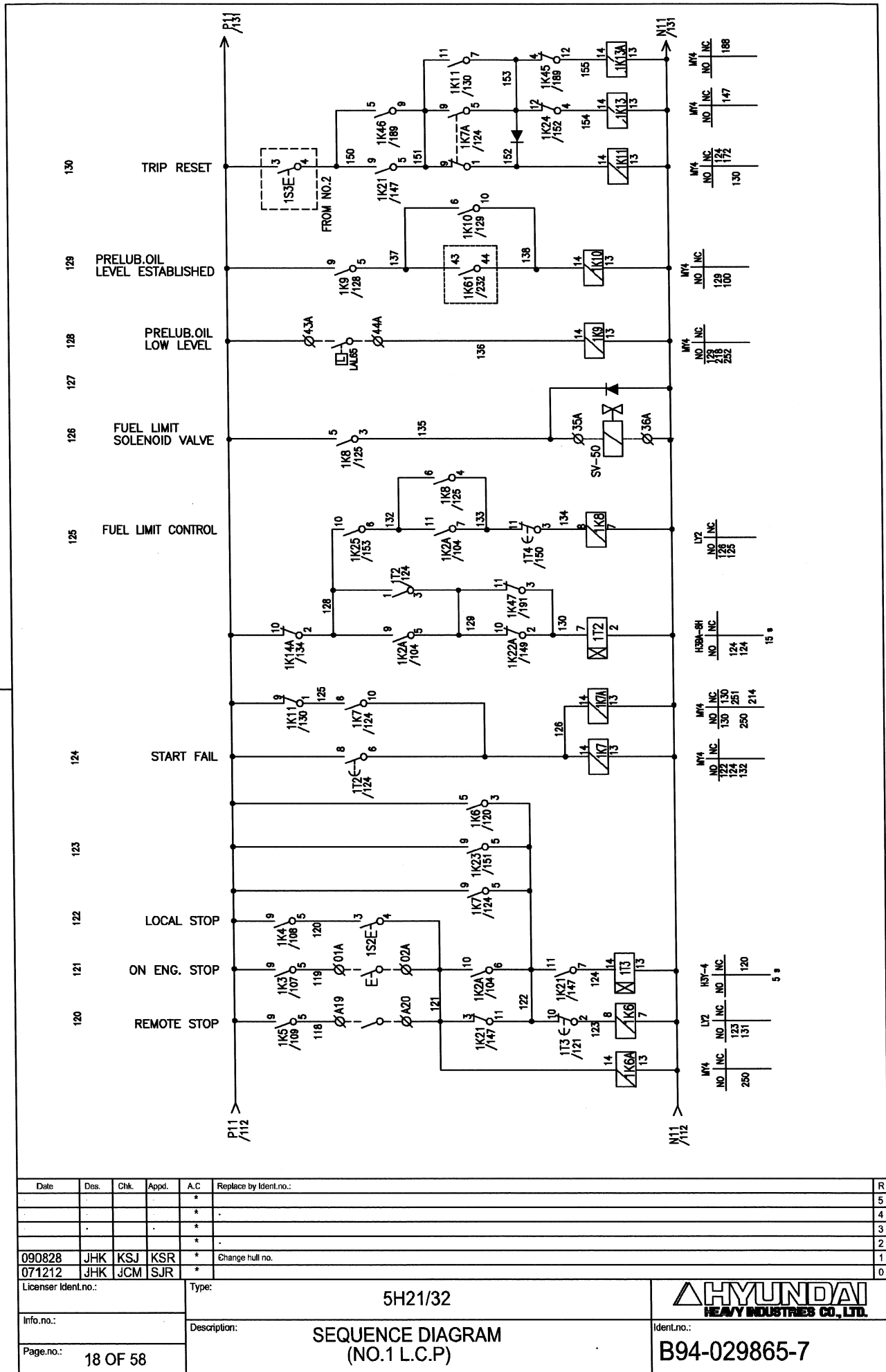
NO. SYMBOL	DESCRIPTION	NAME PLATE MARK	TYPE	QTY	REMARKS
40.1	NAME PLATE	NO.1 PRELUB. OIL PUMP STARTER	8A	1	
40.2	NAME PLATE	NO.2 PRELUB. OIL PUMP STARTER	8A	1	
40.3	NAME PLATE	NO.3 PRELUB. OIL PUMP STARTER	8A	1	
41	MCCB	SOURCE (PRELUB. OIL P/P)	2A	3	
42	LAMP(WHITE)	SOURCE	SQ	3	BULB
43	P/B W/LAMP(GREEN)	START/RUNNING	SQ	3	BULB
44	P/B S.W(RED)	STOP	SQ	3	
45	SELECTOR S.W	MANU - AUTO	SQ	3	
46					
47					
50.1	NAME PLATE	NO.1 JACKET WATER PREHEATER	8A	1	
50.2	NAME PLATE	NO.2 JACKET WATER PREHEATER	8A	1	
50.3	NAME PLATE	NO.3 JACKET WATER PREHEATER	8A	1	
51	MCCB	SOURCE (J.W PREHEATER)	2A	3	
52	LAMP(WHITE)	SOURCE	SQ	3	BULB
53	P/B W/LAMP(GREEN)	START/RUNNING	SQ	3	BULB
54	P/B S.W(RED)	STOP	SQ	3	
55	SELECTOR S.W	MANU - AUTO	SQ	3	
56	BELL	ALARM BELL	2A	1	
57					
60	MAKER N.P	YUMYUNG ENG. CO., LTD.		1	

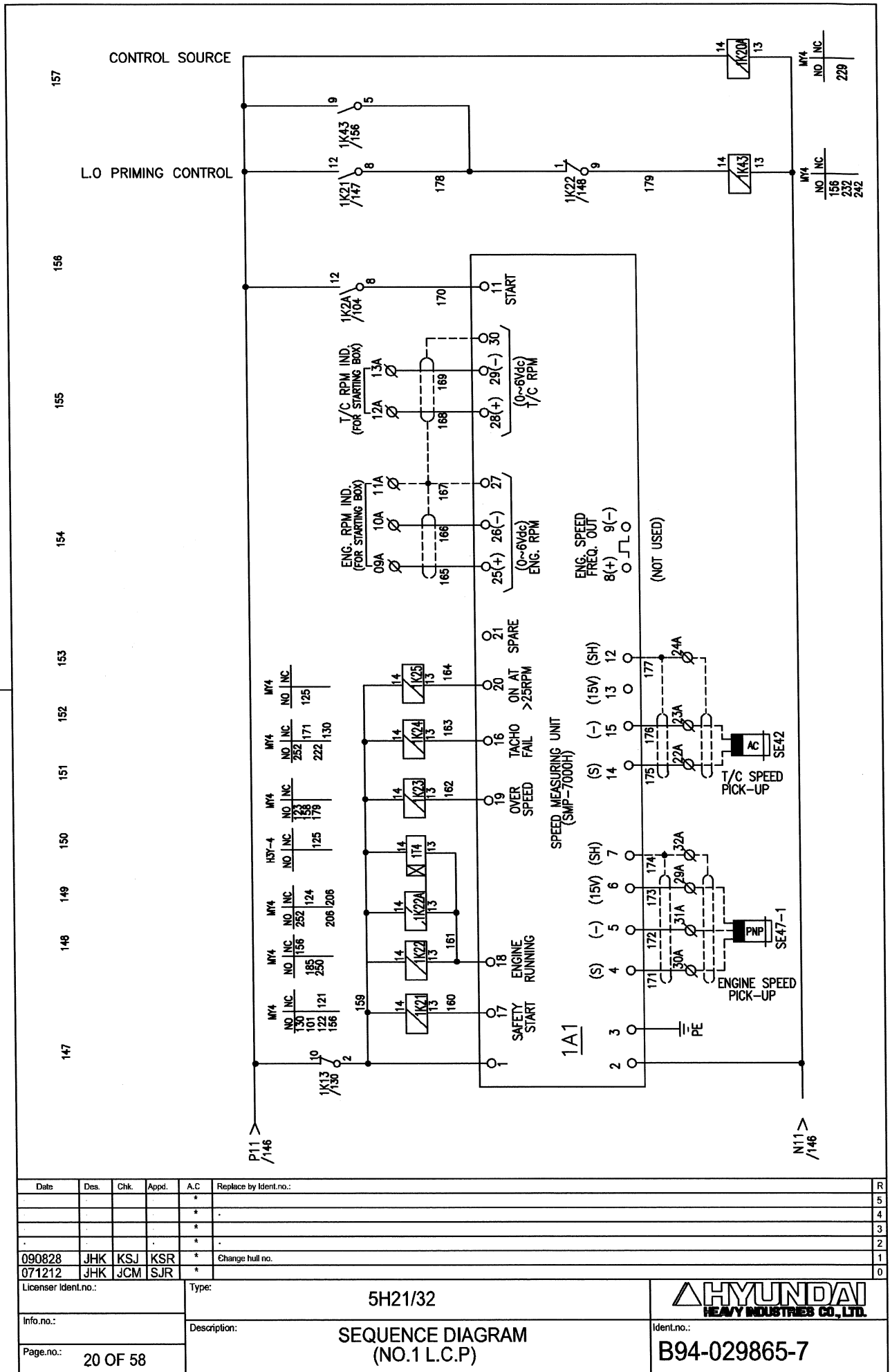


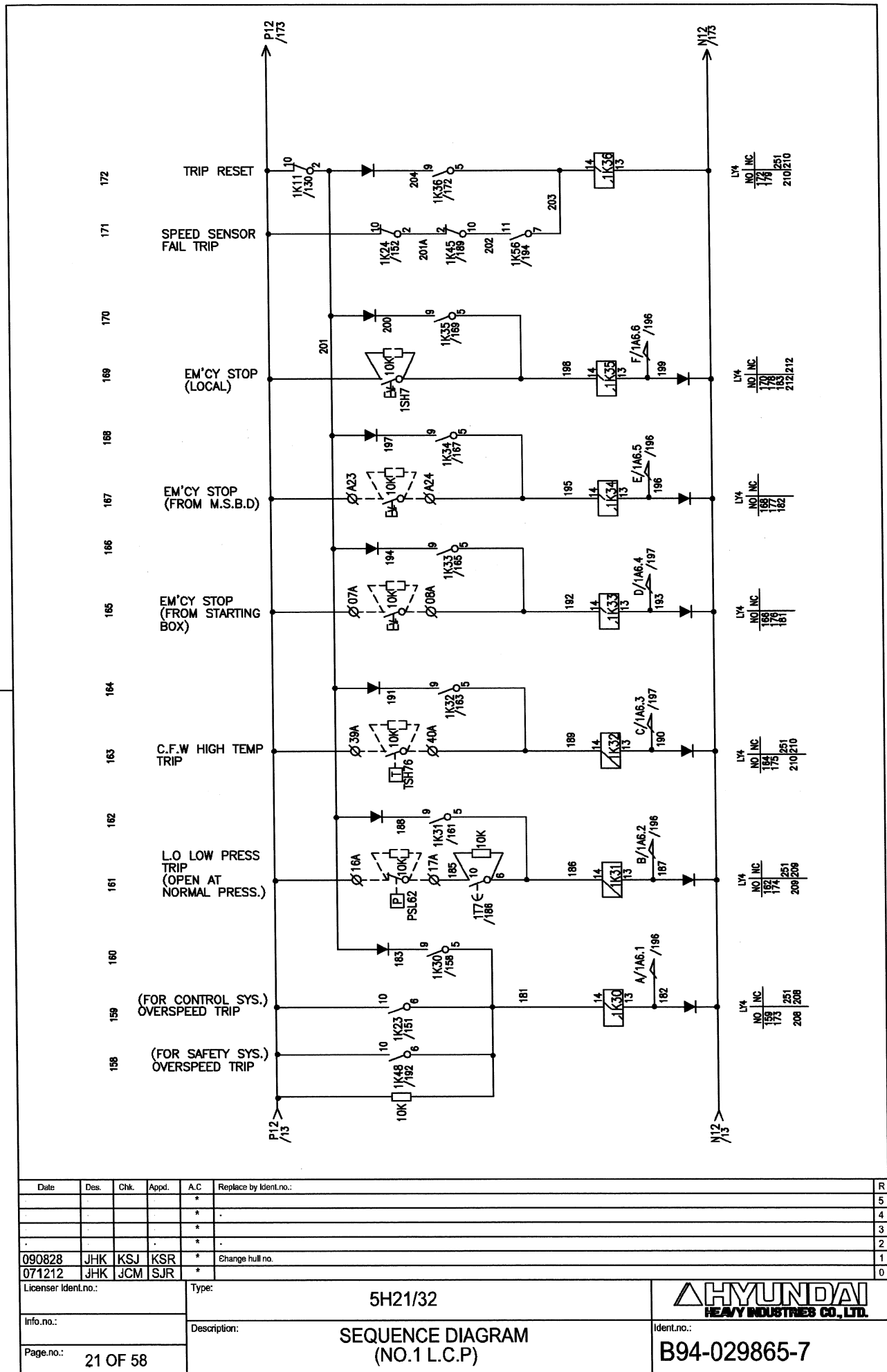


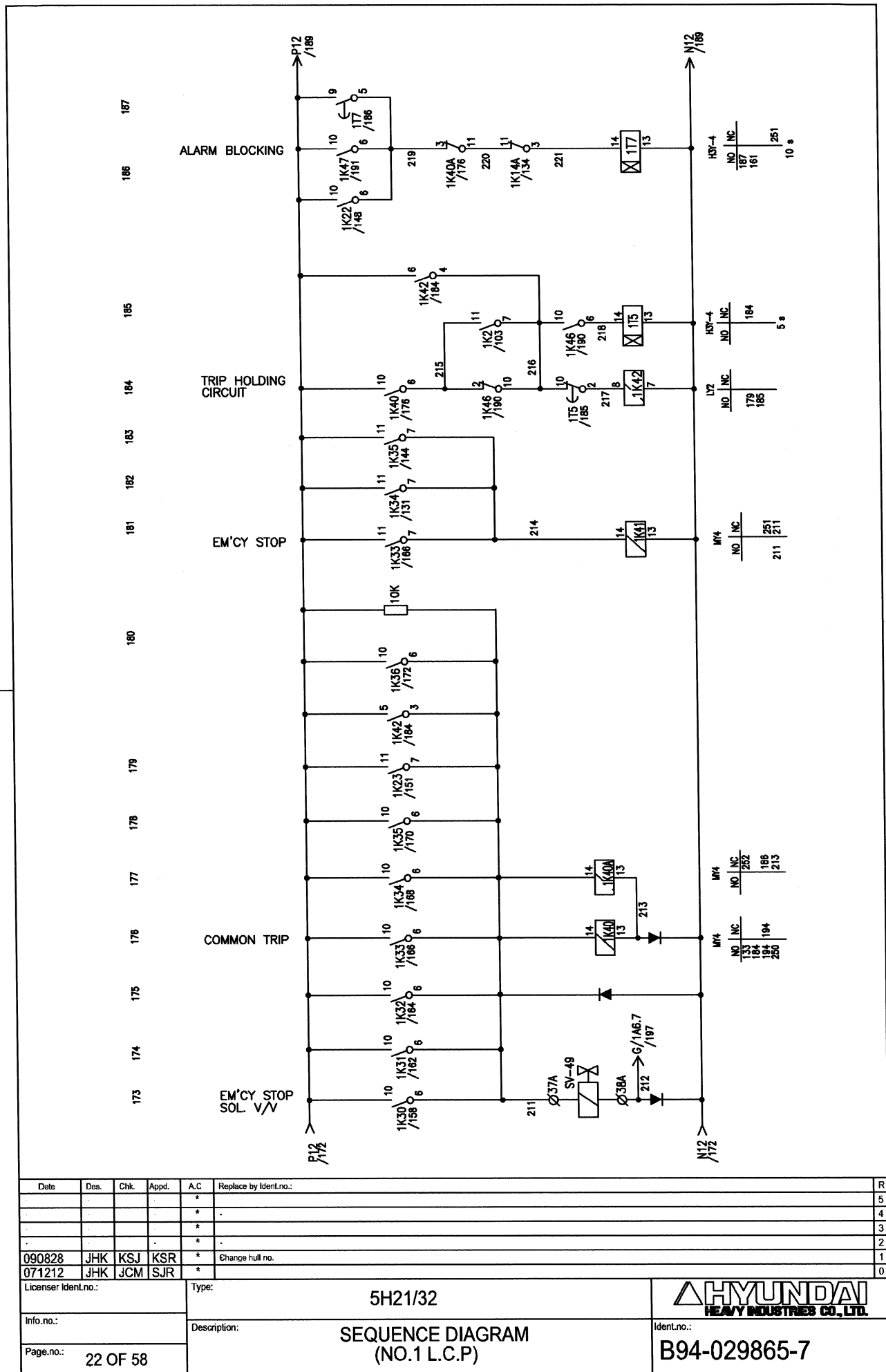


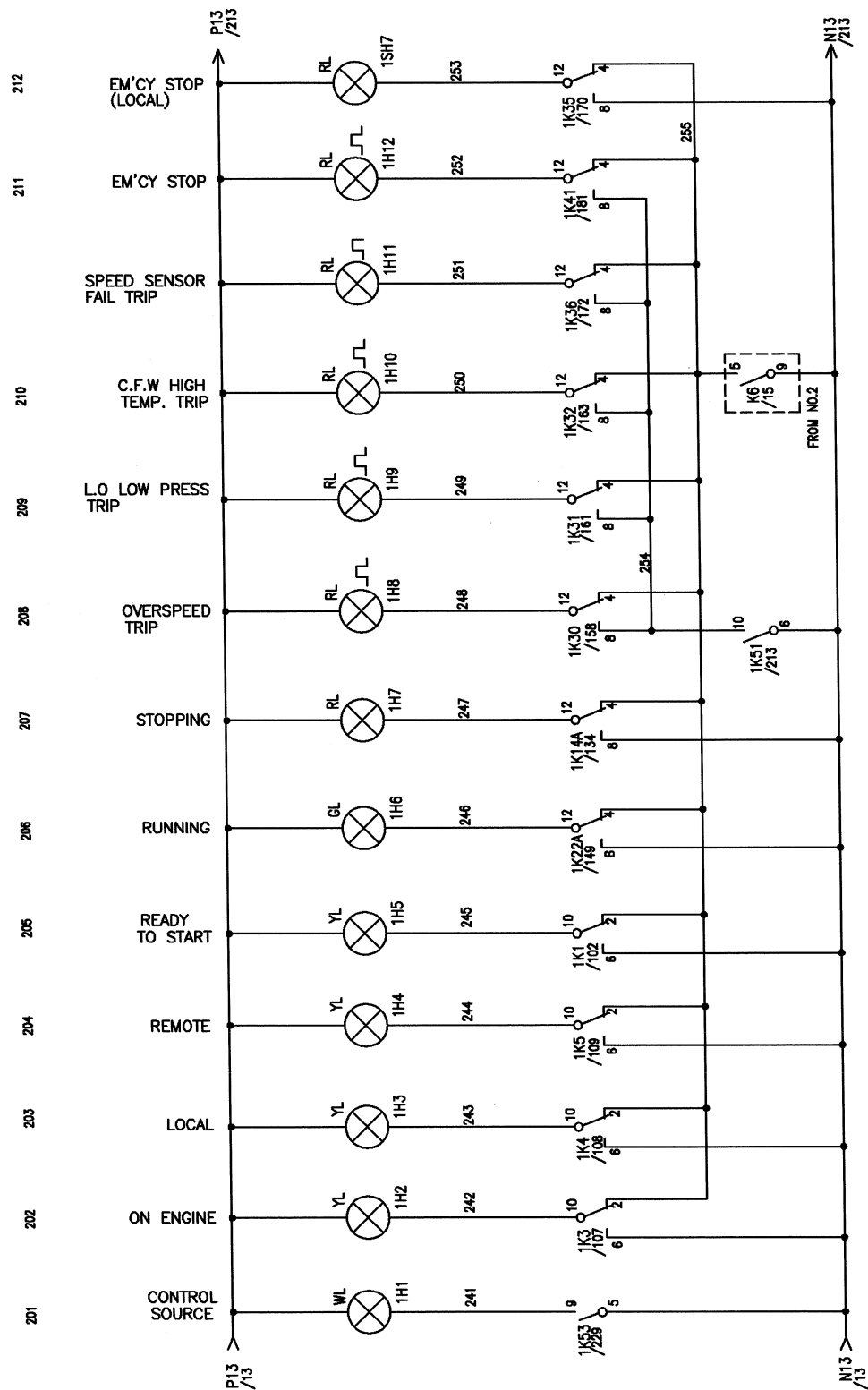
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.No.:				Type:	5H21/32	
Info.no.:				Description:	SEQUENCE DIAGRAM (NO.1 L.C.P)	
Page.no.: 17 OF 58						
						Ident.no.: B94-029865-7



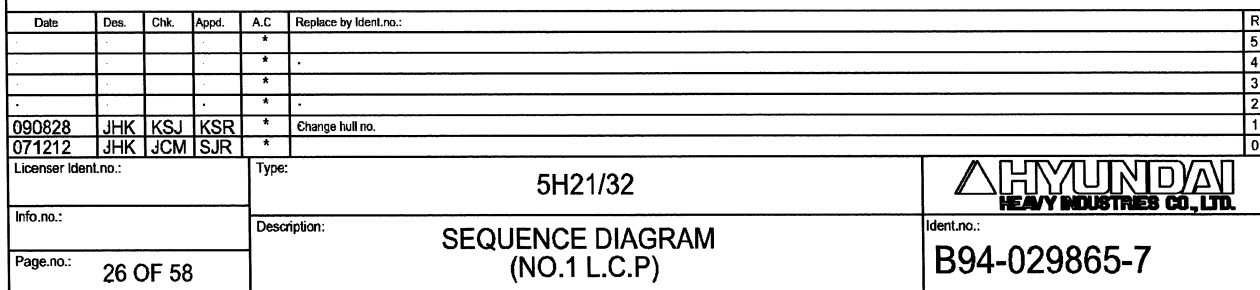


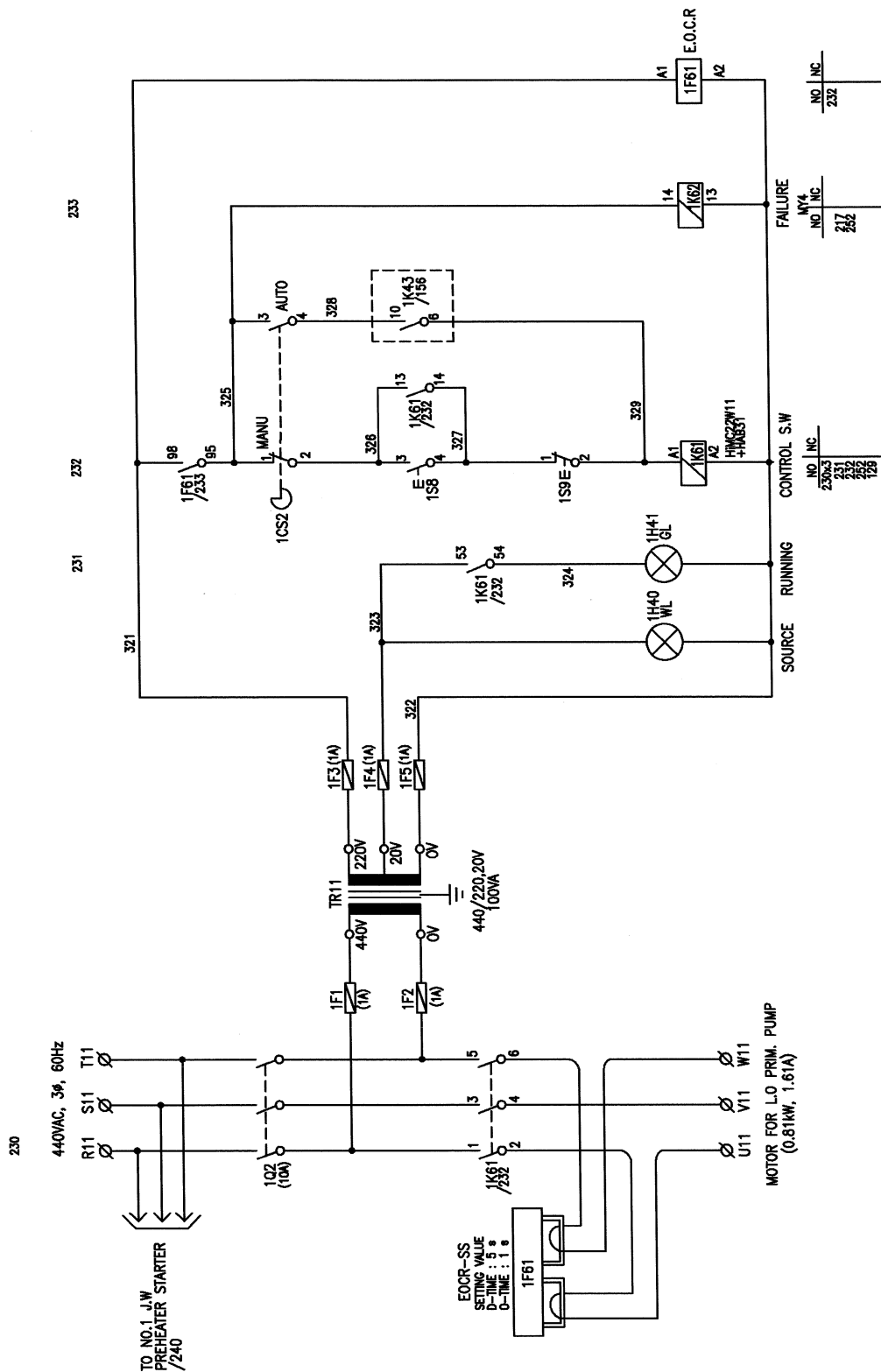






Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	SEQUENCE DIAGRAM (NO.1 L.C.P)	
Page.no.: 24 OF 58						
						Ident.no.: B94-029865-7

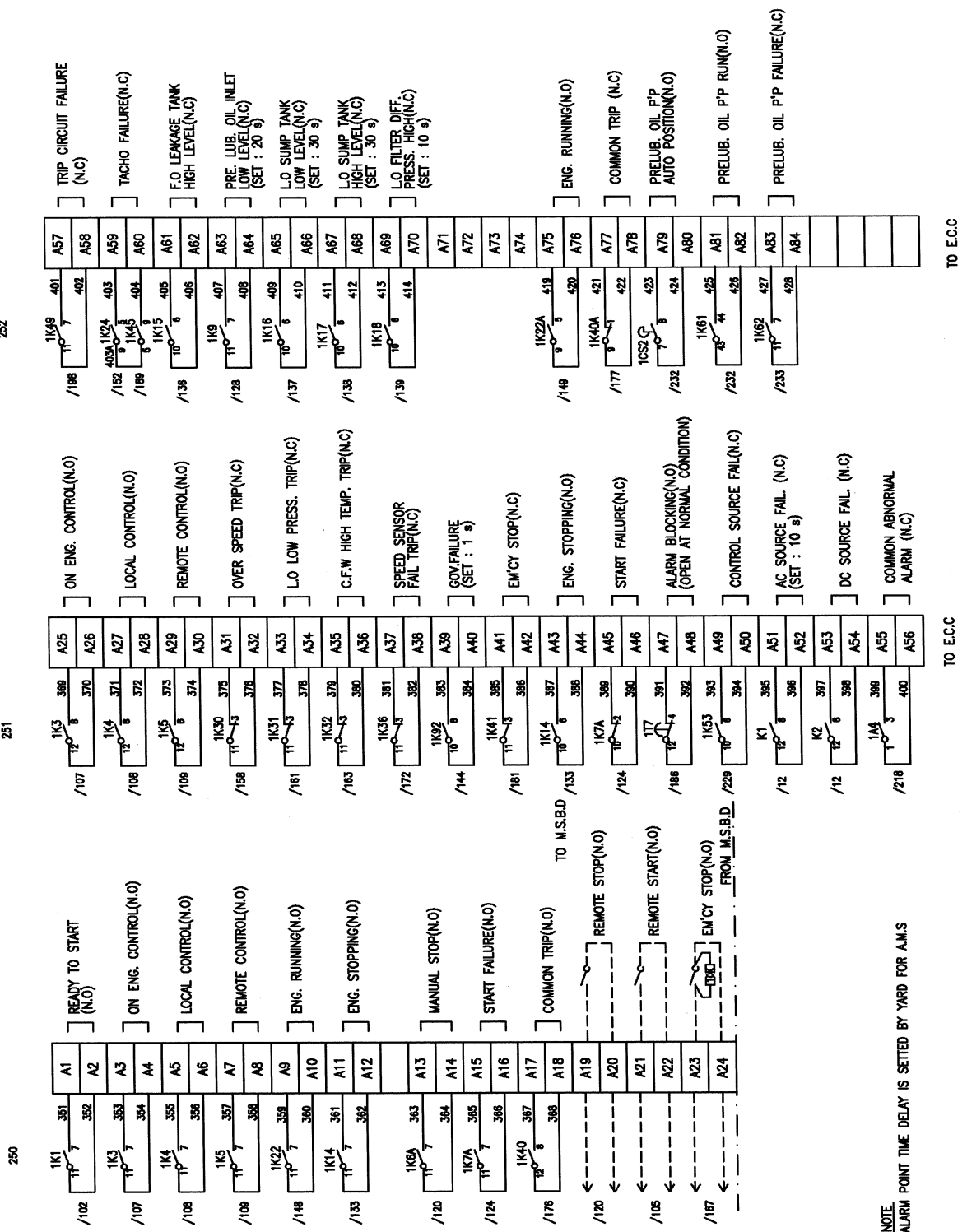


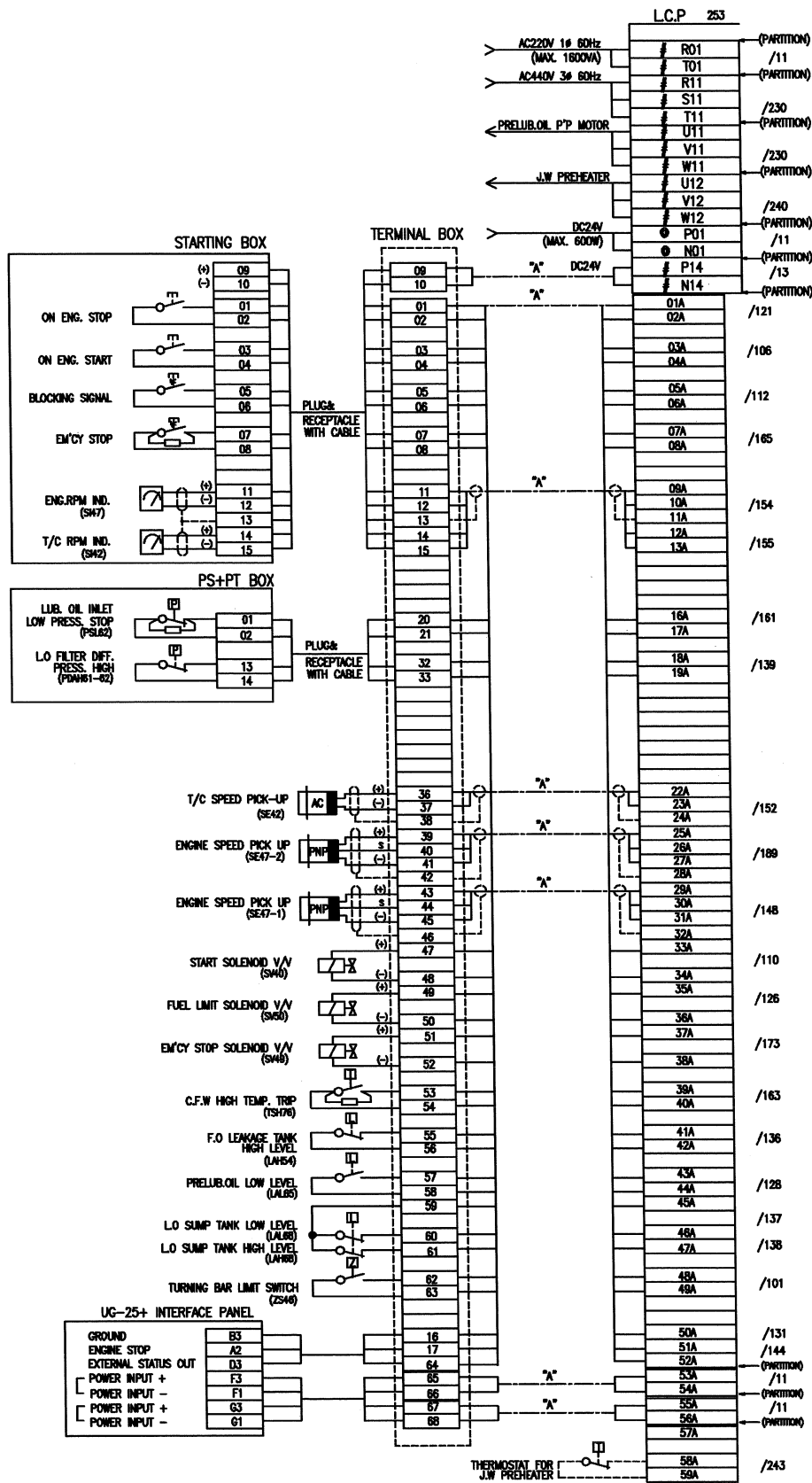


Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	L.O PRIM. PUMP CONTROL (NO.1 PRELUB. OIL P'P)	
Page.no.: 27 OF 58						
						Ident.no.: B94-029865-7

Date	Des.	Chk.	Appd.	A.C.	Replace by Ident.no.:	R	
				*		5	
	-	-		*		4	
	-	-		*	-	3	
				*		2	
090828	JHK	KSJ	KSR	*	Change hull no.	1	
071212	JHK	JCM	SJR	*		0	
Licensor Ident.no.:				Type:	5H21/32		
Info.no.:				Description:	J.W PREHEATER CONTROL (NO.1 J.W PREHEATER)		Ident.no.:
Page.no.: 28 OF 58							B94-029865-7

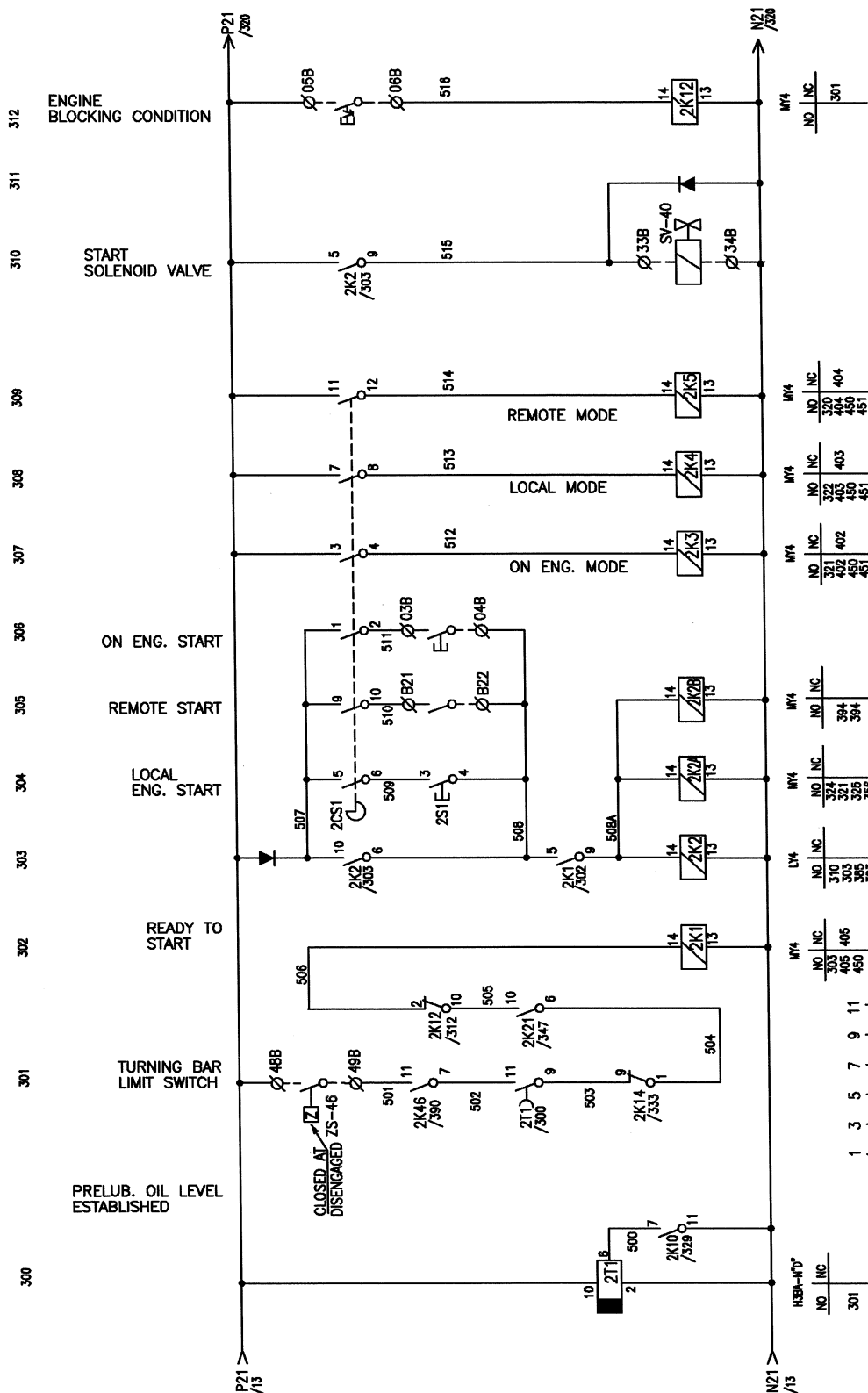
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:		Type: 5H21/32				 Ident.no.: B94-029865-7
Info.no.:		Description: TERMINAL BLOCK WITH CONTACT (NO.1 L.C.P)				
Page.no.: 29 OF 58						





1. THE "A" MARKED CABLE CONNECTION WORK IS CARRIED OUT BY THE YARD. AND CABLES ARE TO BE FURNISHED BY THE YARD.
2. ○ MARK TERMINAL BLOCK : 60A, 145q
3. # MARK TERMINAL BLOCK : 35A, 55sq
4. OTHERS : 15A, 25q

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	TERMINAL BLOCK ARR'T (NO.1 L.C.P.)	
Page.no.: 30 OF 58						
Ident.no.: B94-029865-7						



Date	Des.	Chk.	Appd.	A.C.	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
				*		1
090828	JHK	KSJ	KSR	*	Change hull no.	0
071212	JHK	JCM	SJR	*		
Licensor Ident.no.:						
Type:						
5H21/32						
Info.no.:						
Description:						
SEQUENCE DIAGRAM (NO.2 L.C.P)						
Page.no.:						
31 OF 58						
Ident.no.:						
B94-029865-7						

HYUNDAI
HEAVY INDUSTRIES CO., LTD.

346
345
344
343
342
341
340
339
338
337
336
335
334
333
332
331

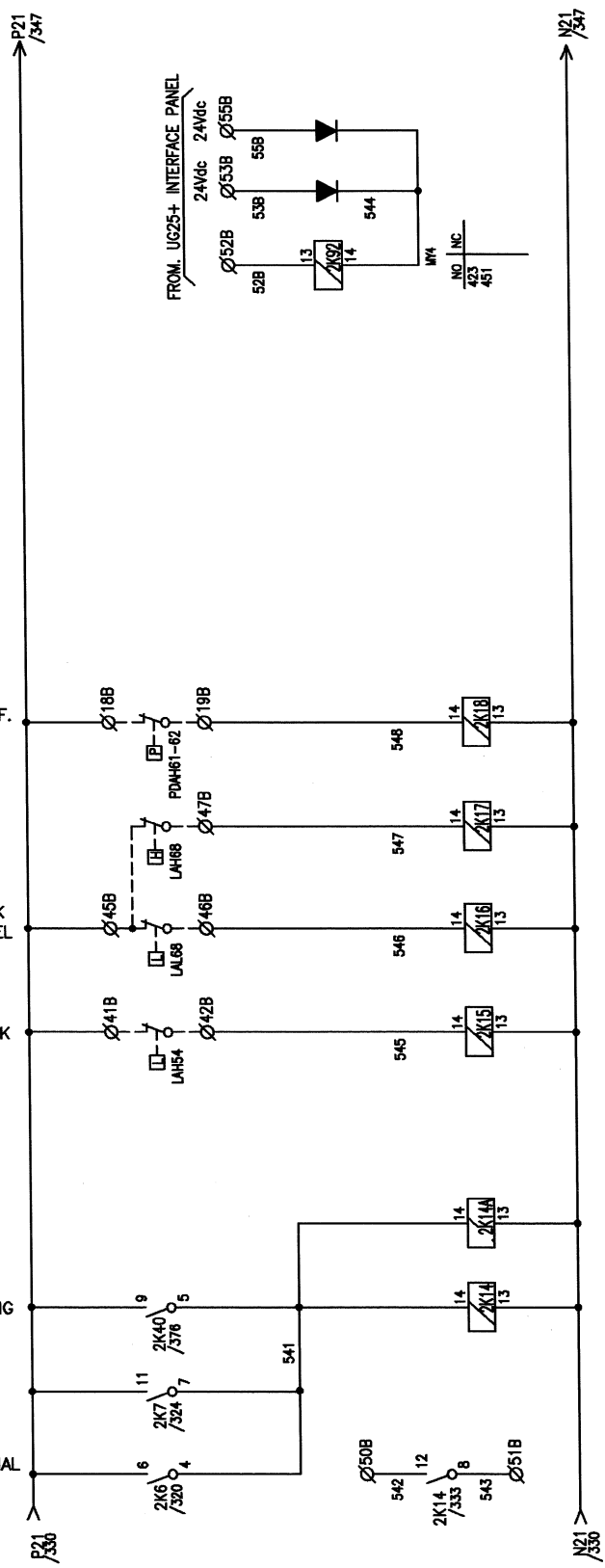
L.O FILTER DIFF.
PRESS. HIGH

L.O SUMP TANK
LOW/HIGH LEVEL

F.O LEAKAGE TANK
HIGH LEVEL

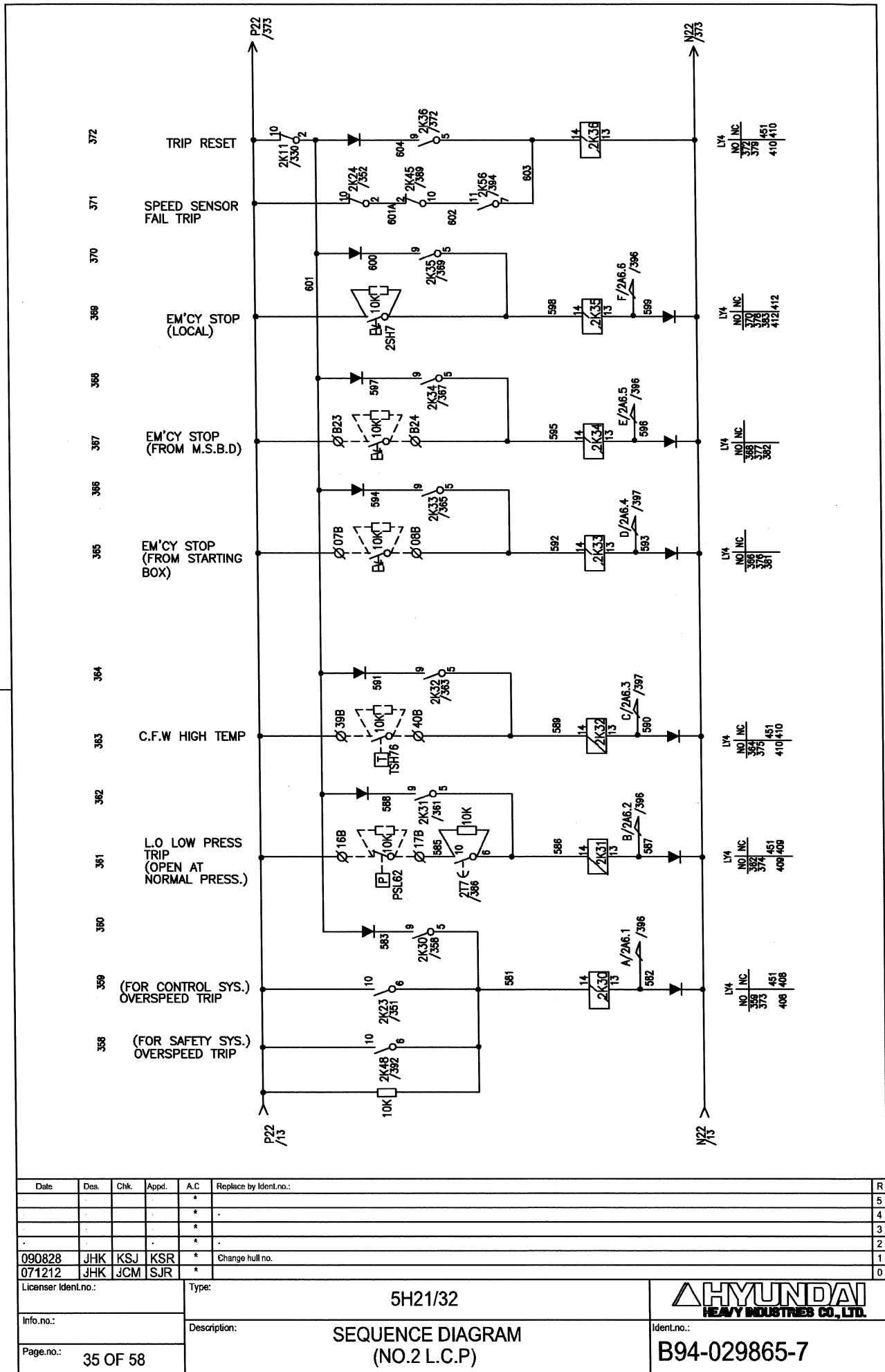
ENG. STOPPING

SHUTDOWN SIGNAL
FOR GOVERNOR



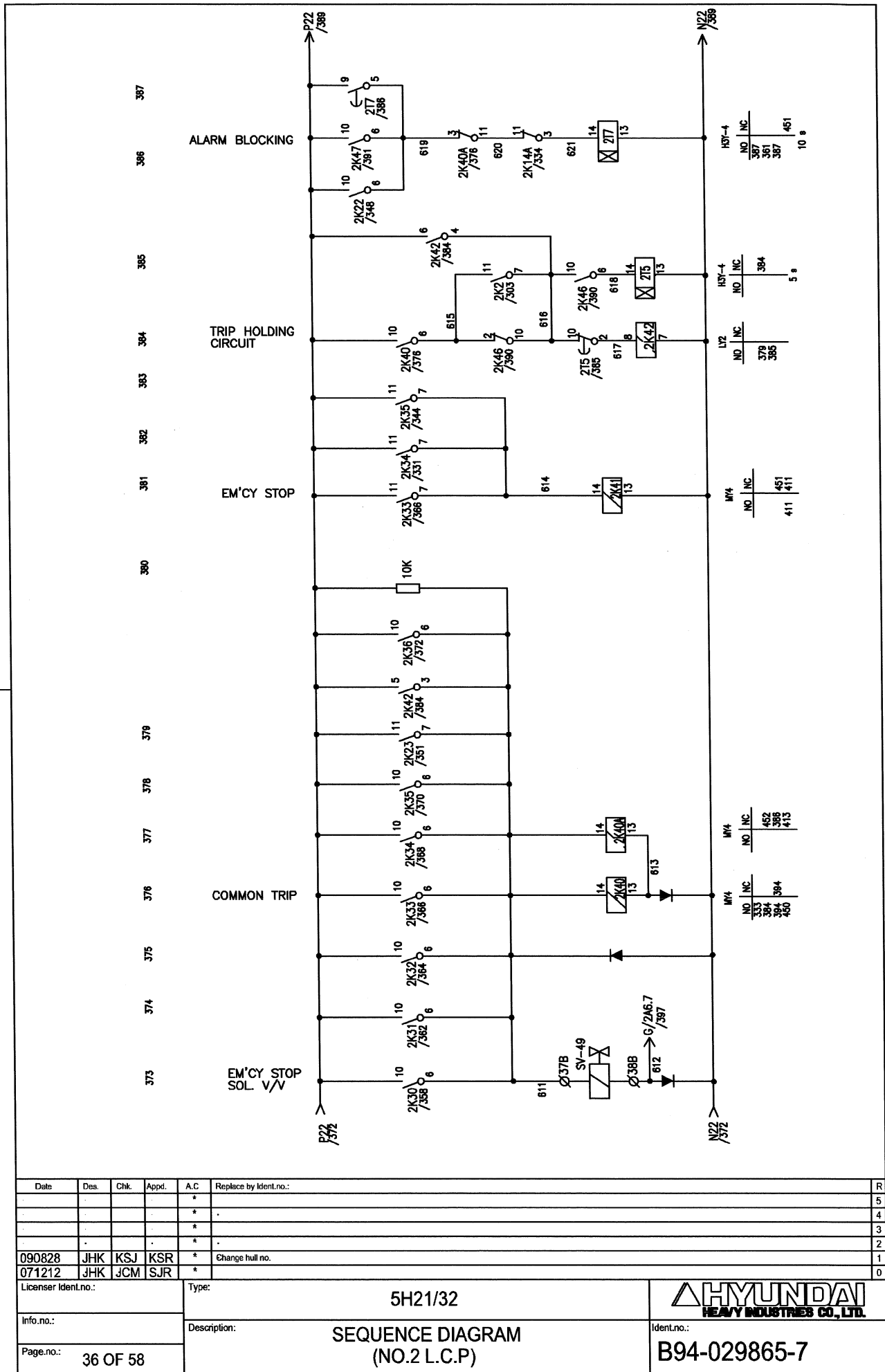
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0

License Ident.No.:	Type:	5H21/32	
Info.no.:	Description:	SEQUENCE DIAGRAM (NO.2 L.C.P)	
Page.no.:			
33 OF 58			Ident.no.:
			B94-029865-7



Date	Des.	Chk.	Appd.	A.C	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.No.:		Type:				
Info.no.:		Description:				
Page.no.:		Ident.no.:				
35 OF 58		5H21/32 SEQUENCE DIAGRAM (NO.2 L.C.P) B94-029865-7				

HYUNDAI
HEAVY INDUSTRIES CO., LTD.



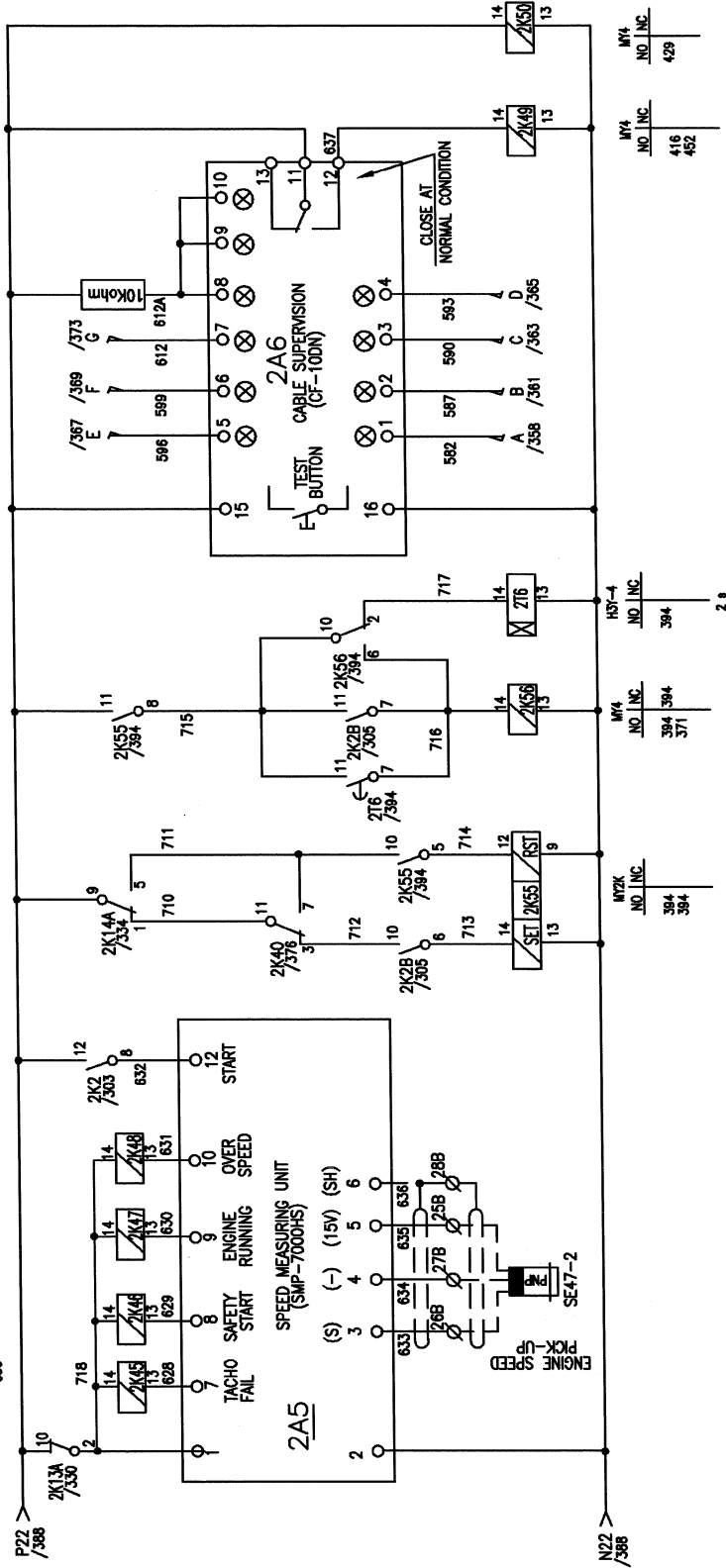
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.No.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:		Type:				
Info.no.:		Description:				
Page.no.:		Ident.no.:				
36 OF 58		5H21/32 SEQUENCE DIAGRAM (NO.2 L.C.P) B94-029865-7				

HYUNDAI
HEAVY INDUSTRIES CO., LTD.

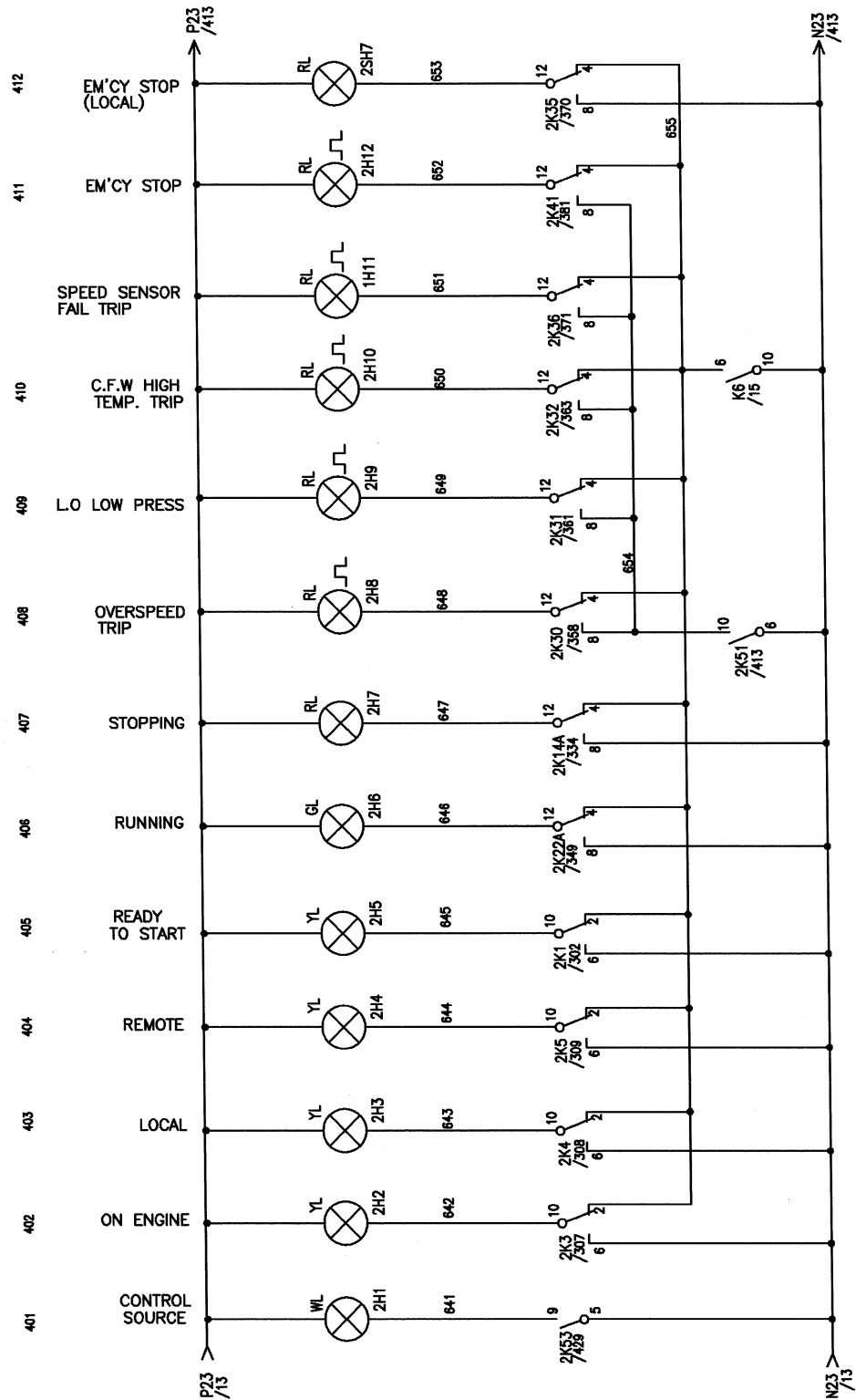
CONTROL SOURCE

SPEED SENSOR FAIL
TRIP RELEASE

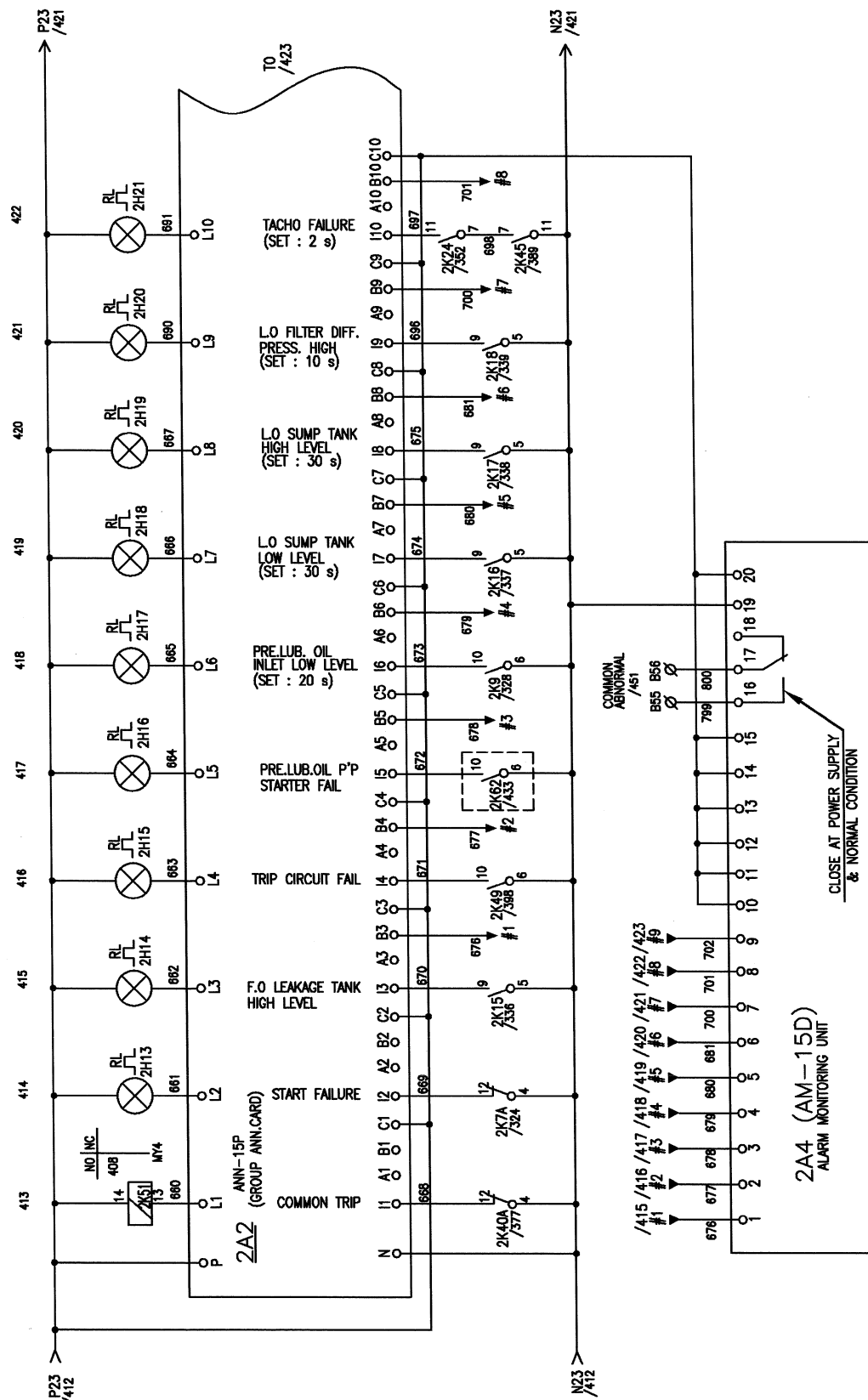
398 399 400 397 396 395 394 393 392 391 390 389 388



Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
				*		1
090828	JHK	KSJ	KSR	*	Change hull no.	0
071212	JHK	JCM	SJR	*		
Licensor Ident.no.:		Type:				
Info.no.:		Description:				
Page.no.:		Ident.no.:				
37 OF 58		5H21/32				
		SEQUENCE DIAGRAM (NO.2 L.C.P)				
		B94-029865-7				



Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	SEQUENCE DIAGRAM (NO.2 L.C.P)	
Page.no.: 38 OF 58						
Ident.no.: B94-029865-7						



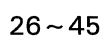
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:		Type:				
Info.no.:		Description:				
Page.no.:		Ident.no.:				
39 OF 58		5H21/32				
		SEQUENCE DIAGRAM (NO.2 L.C.P)				
		B94-029865-7				

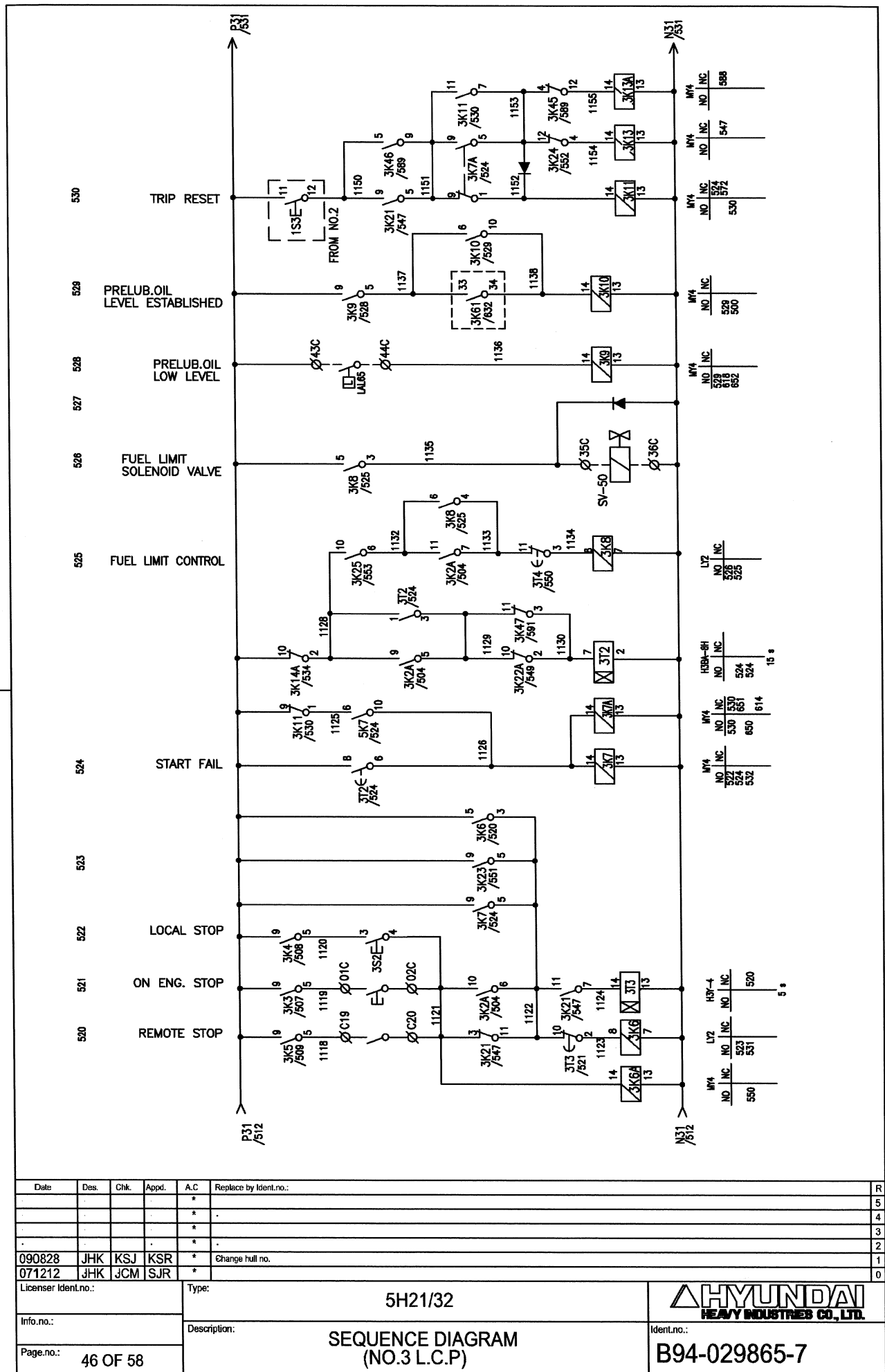
HYUNDAI
HEAVY INDUSTRIES CO., LTD.

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
.	.	.	.	*	
.	.	.	.	*	.
.	.	.	.	*	
.	.	.	.	*	.
090828	JHK	KSJ	KSR	*	Change hull no.
071212	JHK	JCM	SJR	*	

Licenser Ident.no.:	Type: 5H21/32	
Info.no.:	Description: SEQUENCE DIAGRAM (NO.2 L.C.P)	
Page.no.: 40 OF 58	Ident.no.: B94-029865-7	

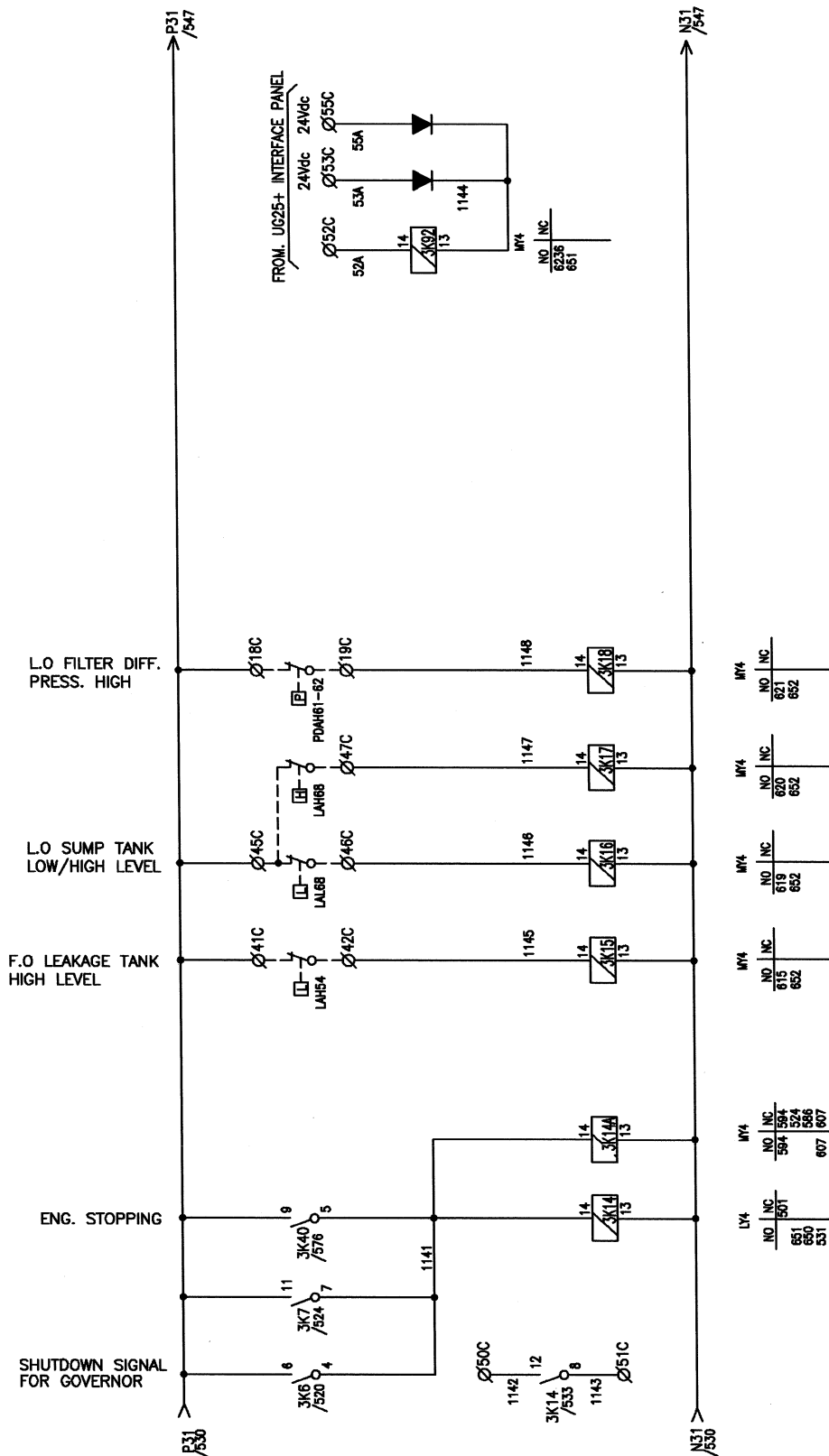
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R	
				*		5	
				*		4	
	-	-		*	-	3	
				*		2	
090828	JHK	KSJ	KSR	*	Change hull no.	1	
071212	JHK	JCM	SJR	*		0	
Licensor Ident.no.:				Type:	5H21/32		
Info.no.:				Description:	J.W PREHEATER CONTROL (NO.2 J.W PREHEATER)		Ident.no.:
Page.no.: 42 OF 58							B94-029865-7



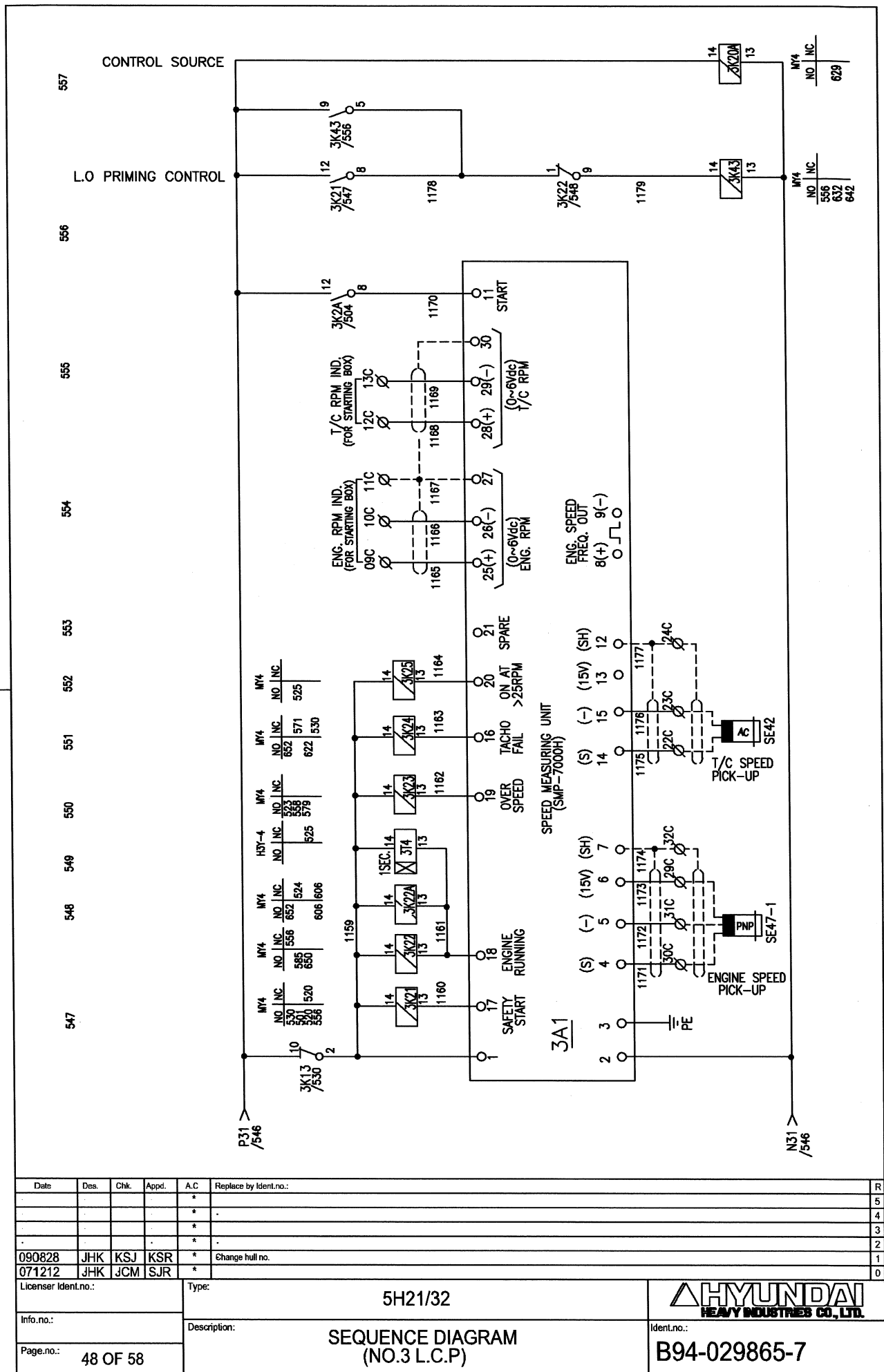


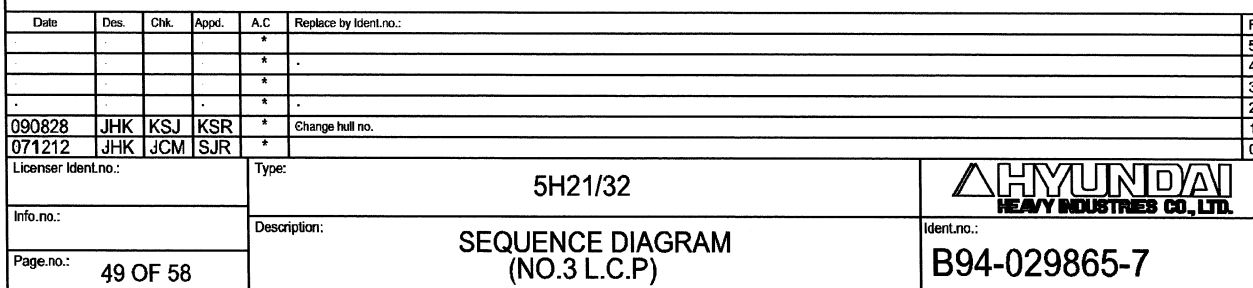
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	SEQUENCE DIAGRAM (NO.3 L.C.P)	
Page.no.: 46 OF 58						
Ident.no.: B94-029865-7						

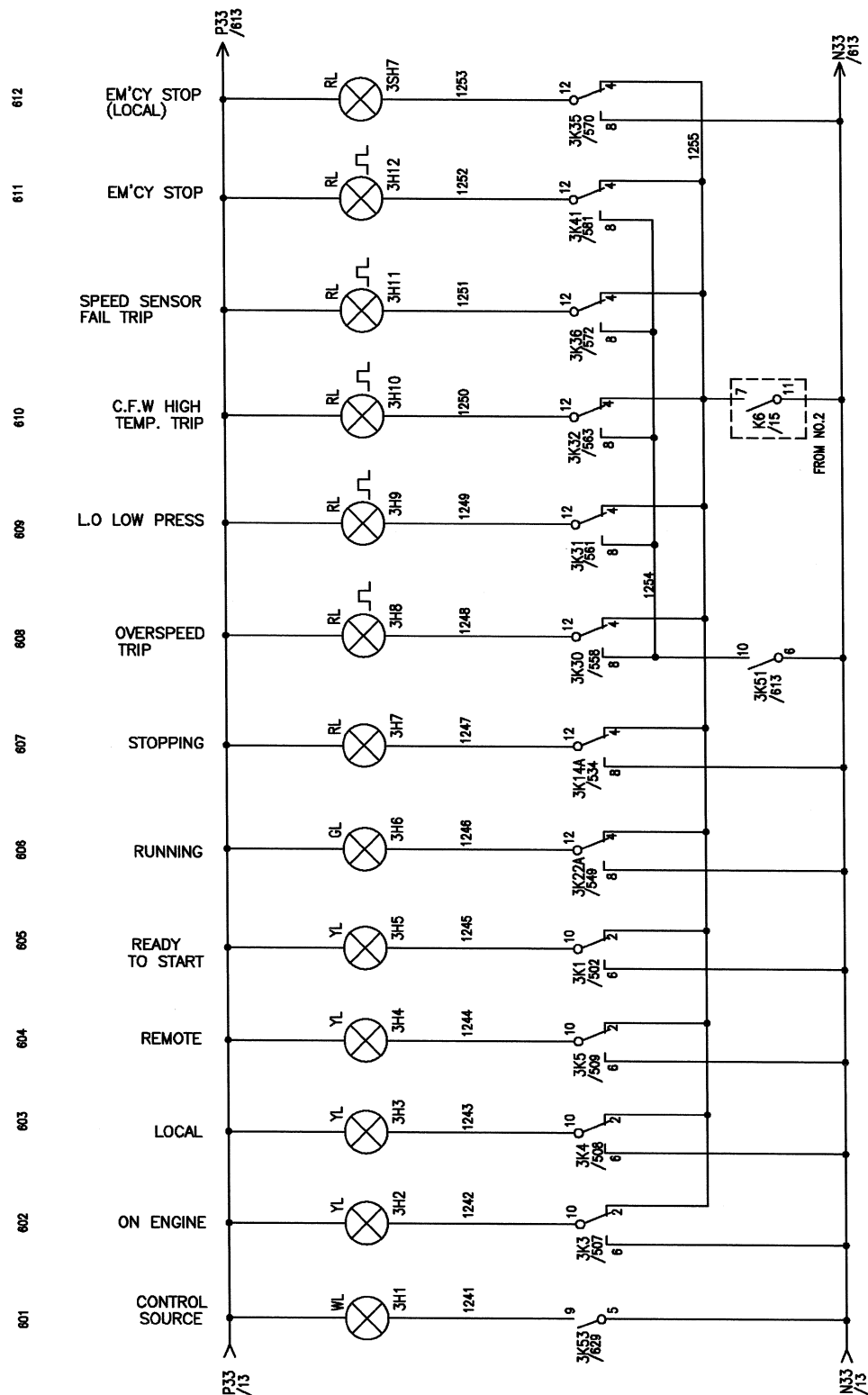
546
545
544
543
542
541
540
539
538
537
536
535
534
533
532
531



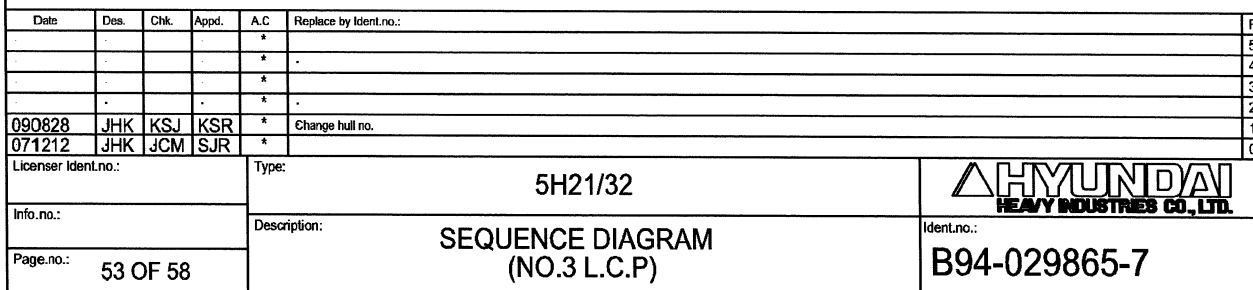
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	SEQUENCE DIAGRAM (NO.3 L.C.P)	
Page.no.: 47 OF 58						
Ident.no.: B94-029865-7						

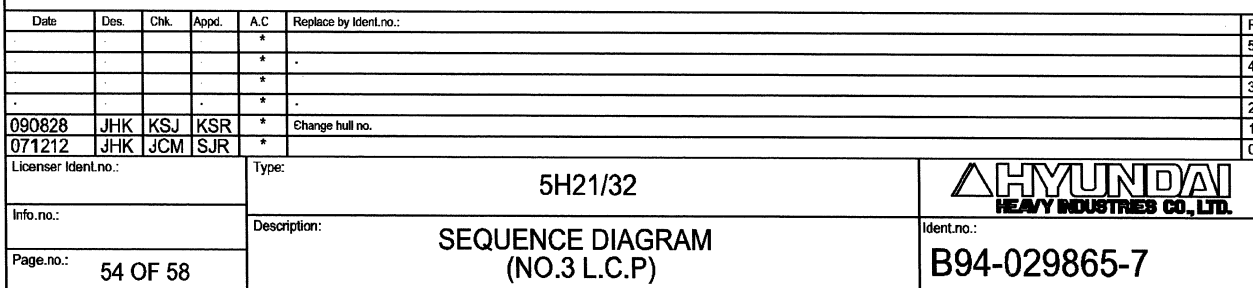






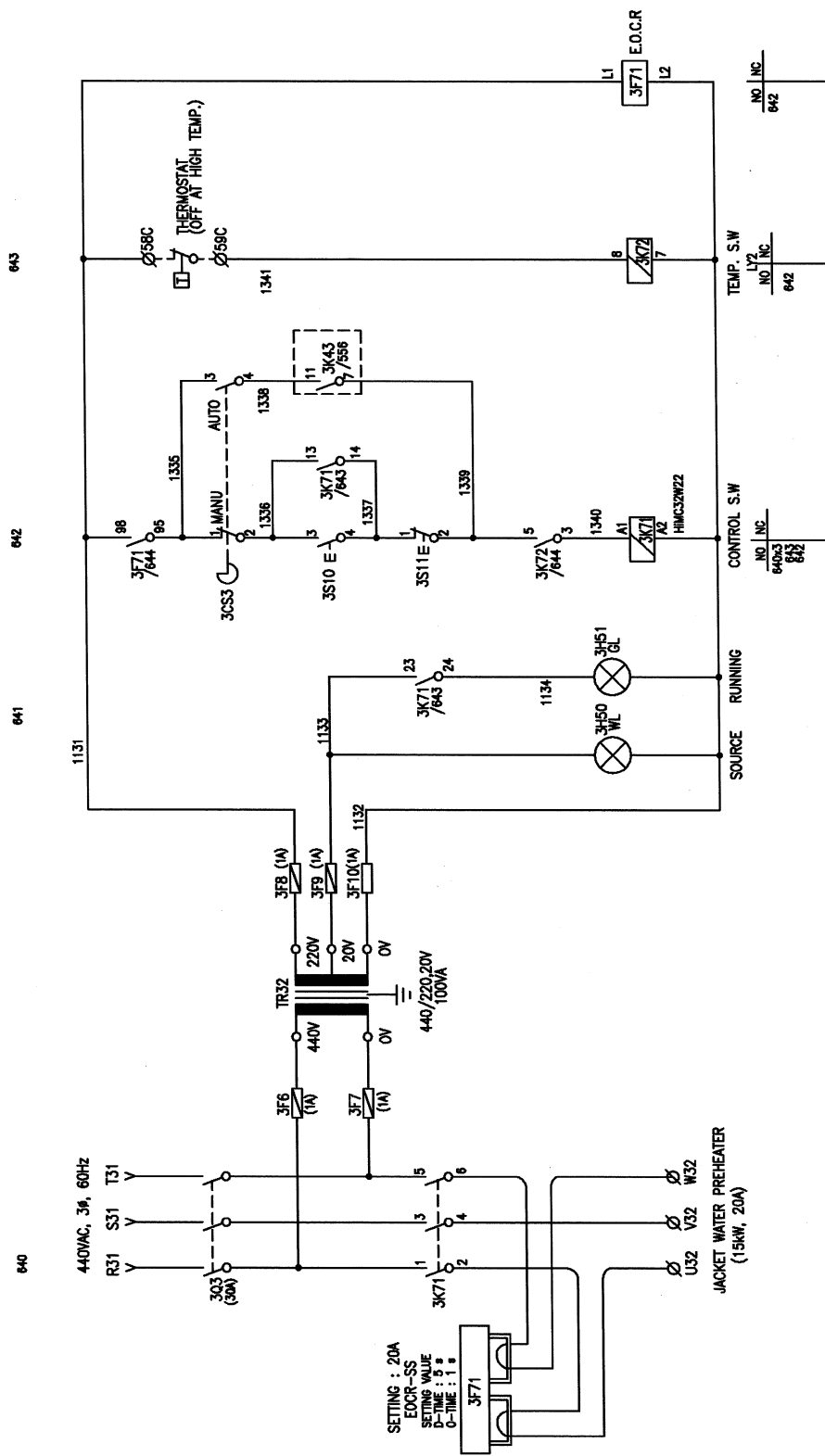
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	SEQUENCE DIAGRAM (NO.3 L.C.P)	
Page.no.: 52 OF 58						
Ident.no.: B94-029865-7						





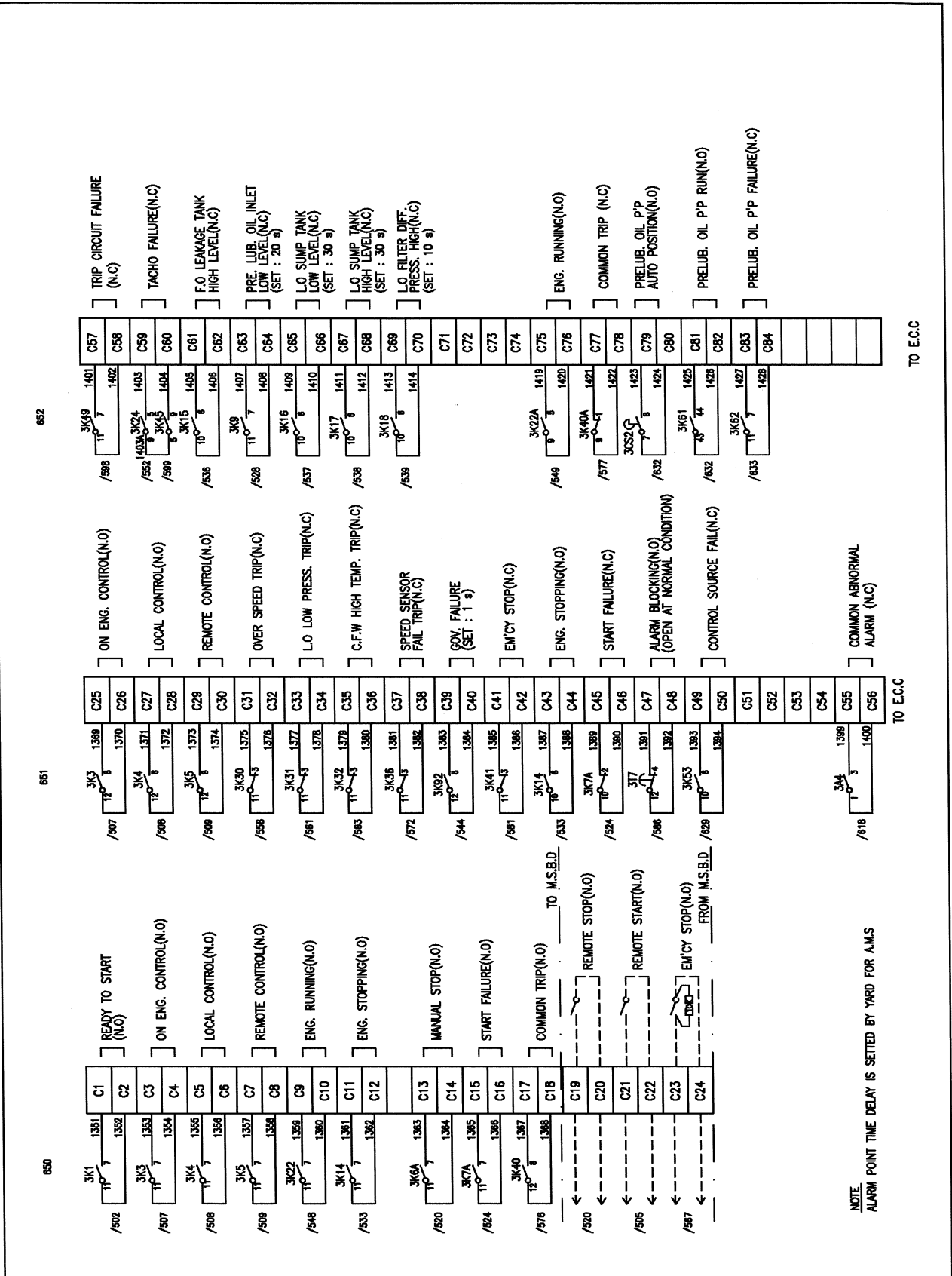
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	F
				*		5
				*	-	4
				*		3
				*	-	2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0

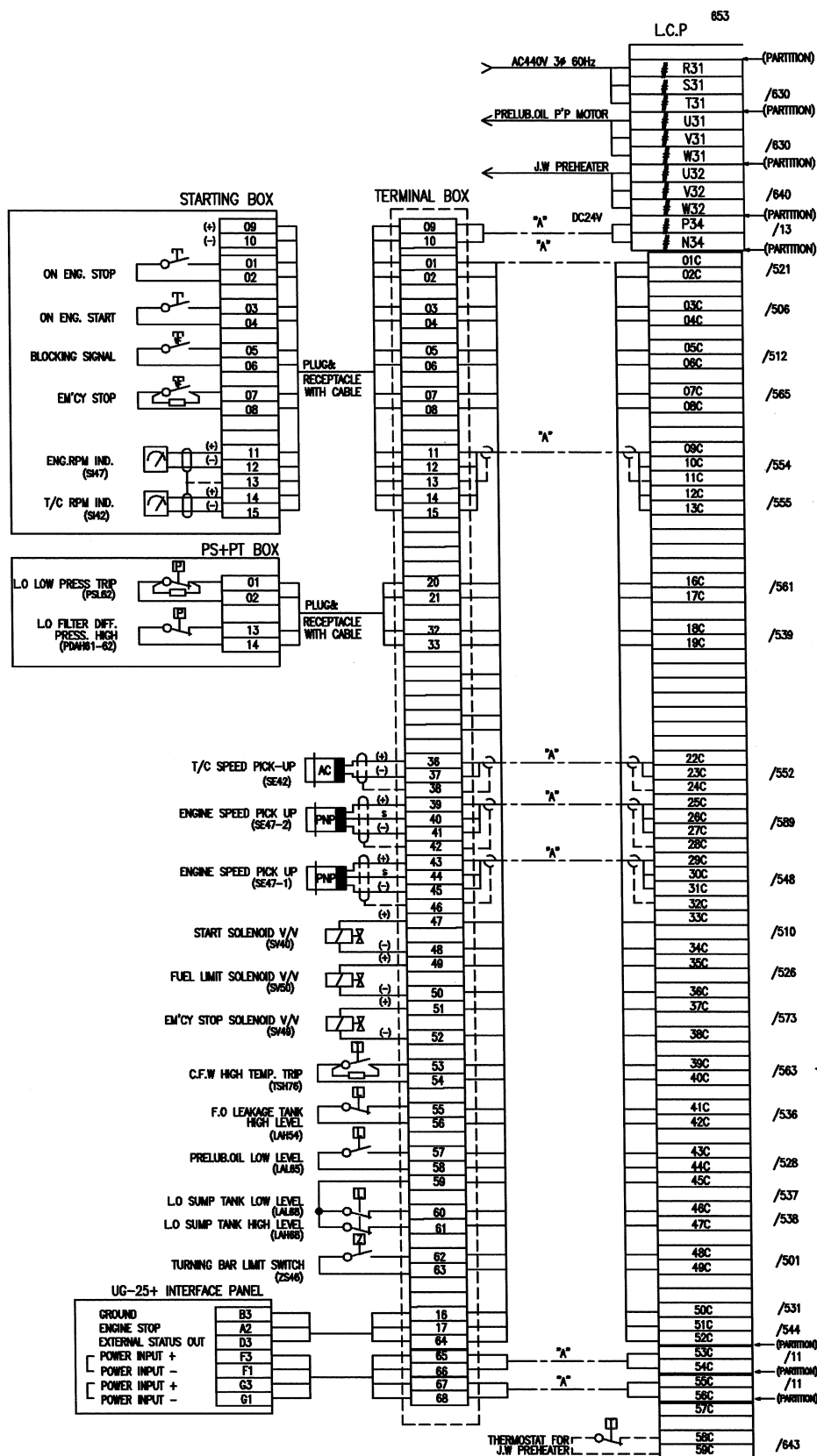
Licenser Ident.no.:		Type:	5H21/32	
Info.no.:		Description:	L.O PRIM. PUMP CONTROL (NO.3 PRELUB. OIL PUMP)	
Page.no.: 55 OF 58				
				Ident.no.: B94-029865-7



Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:		
Info.no.:				Description:		
Page.no.: 56 OF 58				5H21/32 J.W PREHEATER CONTROL (NO.3 J.W PREHEATER)		
				Ident.no.: B94-029865-7		

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:		Type:				
Info.no.:		Description:				
Page.no.:		5H21/32 TERMINAL BLOCK WITH CONTACT (NO.3 L.C.P)				
57 OF 58		Ident.no.:				B94-029865-7





1. THE "A" MARKED CABLE CONNECTION WORK IS CARRIED BY THE YARD.
OUT BY THE YARD. AND CABLES ARE TO BE FURNISHED BY THE YARD.
2. Ⓢ MARK TERMINAL BLOCK : 60A, 145q
3. Ⓢ MARK TERMINAL BLOCK : 35A, 55q
4. OTHERS : 15A, 25q

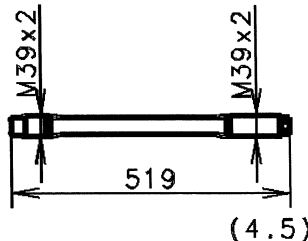
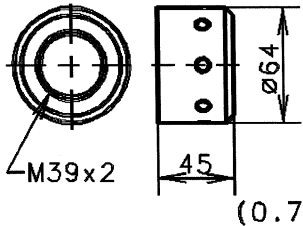
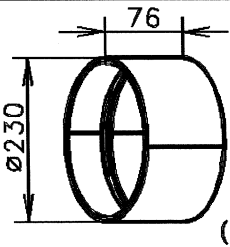
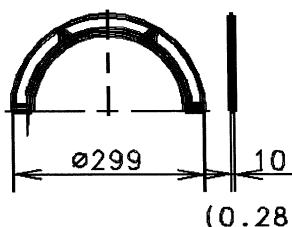
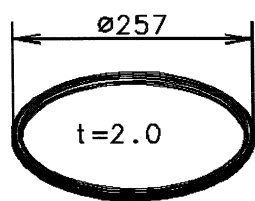
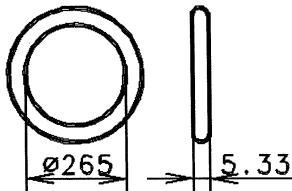
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
090828	JHK	KSJ	KSR	*	Change hull no.	1
071212	JHK	JCM	SJR	*		0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	TERMINAL BLOCK ARR'T (NO.3 L.C.P)	
Page.no.: 58 OF 58						
Ident.no.: B94-029865-7						

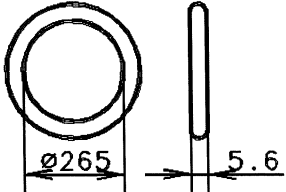
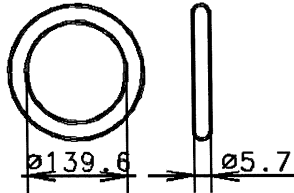
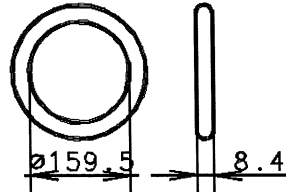
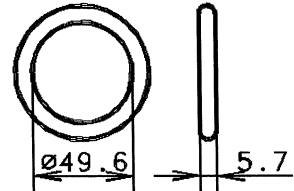
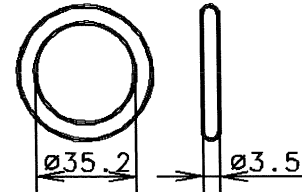
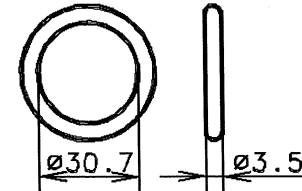
PLAN HISTORY	ENGINE	HYUNDAI-HIMSEN
	TYPE	5H21/32
	 MESSERS	Yangfan Group, Co.Ltd
	RULE	ABS
	 PROJECT	YANGFAN2003/2004/2005 YANGFAN2006/2007/2008
	 ENG. NO.	BA2768/2769/2770 BA2771/2772/2773

TITLE: LIST OF SPARE PARTS FOR D/G ENGINE

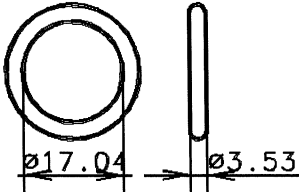
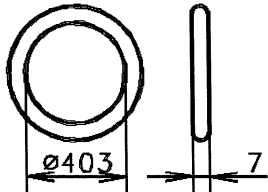
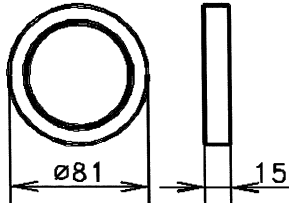
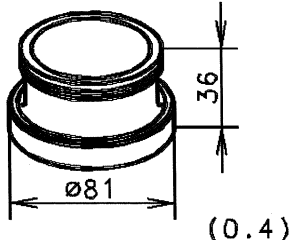
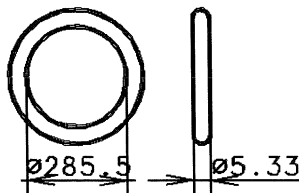
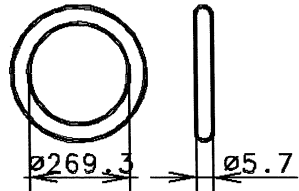
1. STANDARD SPARE PARTS ----- B94-030154-8.3
(SC-7-1~SC-7-7)
2. STANDARD SPARE PARTS ----- B94-017626-8.1
(SP-1-1~SP-1-2)
3. STANDARD SPARE PARTS FOR A/C ----- B94-023501-1.0
(SC-1-1)
4. SPARE PARTS FOR L.C.P. ----- B94-029866-9.1
(SE-1-1)
5. SPARE PARTS FOR YARD WORKING ----- B94-029620-7.0
(SC-1-1)

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
090824	CHM	KCS	KCS	*	CHANGED HULL NO. OF NO.4. REVISED	2
080813	UMJ	KSW	KSW	*	REVISED DWG NO. OF NO.1~2	1
071226	UMJ	KSW	KSW	*	Replacement for Ident.no.:	0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	LIST OF SPARE PARTS	
Page.no.:						
1 OF 12						B94-031601-1

ITEM NO.	NAME	SKETCH (WEIGHT)kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.	
SC01	STUD FOR MAIN BEARING M39x2x519		SNCM439	(2/cyl.+4)xeng.	2	A13000 -231		DS01/S011	
SC02	NUT M39x2		SNCM439	(2/cyl.+4)xeng.	2	A13000 -232	for main bearing stud	DS01/S011	
SC03	MAIN BEARING		MAKER	(1/cyl.+2)xeng.	1	A13250 -251		DS01/S011	
SC04	THRUST WASHER		MAKER	2/eng.	2	A13250 -252		DS01/S011	
SC05	SEALING RING		SPCC	1/cyl.	1	A15000 -191	for cyl. liner	DS01/S011	
SC06	O-RING 265x5.33		VITON FPM70 SHA)	1/cyl.	1	A15000 -192	for cyl. liner	DS01/S011	
Similar no.:		Ship no.:		Scale:		Mass. (kg):			
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:				R
				*					5
				*					4
080610	UMJ	KSW	KSW	*	MOD.DIMENSION (ITEM SC07)				3
080229	KGH	KSW	KSW	*	MOD. NAME				2
080221	UMJ	KSW	KSW	*	MOD. NAME				1
071128	KHA	KSW	KSW	*	Replacement for Ident.no.:				0
SPARES		Type: H21/32				HYUNDAI HEAVY INDUSTRIES CO., LTD.			
Info. no. -		Description: STANDARD SPARE PARTS				Ident.no.: B94-030154-8			

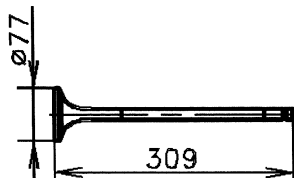
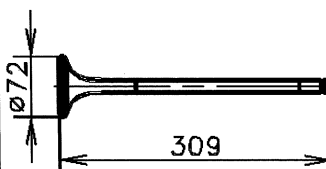
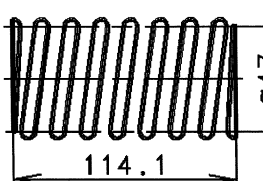
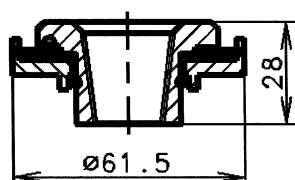
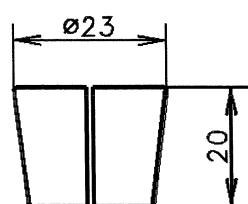
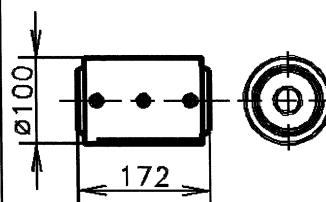
ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SC07	O-RING 265x5.6		VITON FPM70 SHA)	1/cyl.	1	A15000 -193	for cyl. liner	DS01/S011
SC08	O-RING P140		VITON (FPM70 SHA)	1/cyl.	1	A15000 -901	for cool.water jacket	DS01/S011
SC09	O-RING P160		VITON (FPM70 SHA)	1/cyl.	1	A15000 -902	for cool.water jacket	DS01/S011
SC10	O-RING P50A		VITON (FPM70 SHA)	2/cyl.	2	A15000 -903	for cool.water jacket	DS01/S011
SC11	O-RING P35.5		VITON (FPM70 SHA)	1/cyl.	1	A15000 -922	for cool.water conn.	DS01/S011
SC12	O-RING P31		VITON (FPM70 SHA)	1/cyl.	1	A15000 -923	for cool.water conn.	DS01/S011

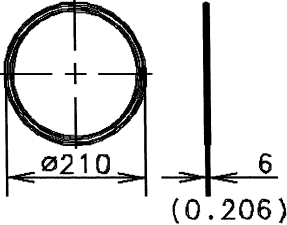
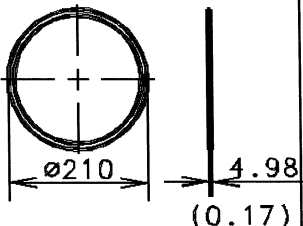
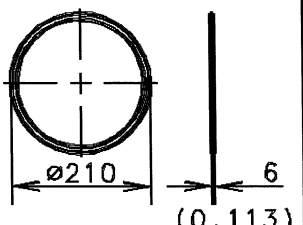
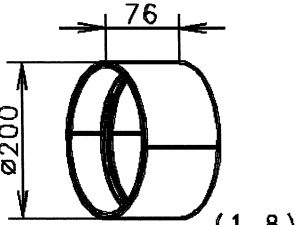
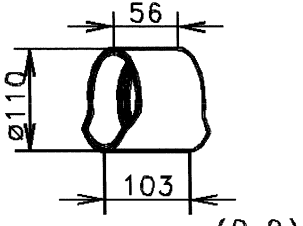
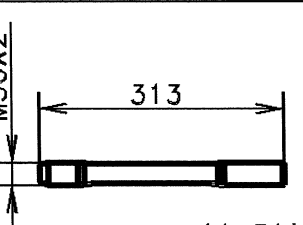
Similar no.:					Ship no.:					Scale:					Mass. (kg):				
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:														
				*															
				*															
080610	UMJ	KSW	KSW	*	MOD.DIMENSION(ITEM SC07)														
080229	KGH	KSW	KSW	*	MOD. NAME														
080221	UMJ	KSW	KSW	*	MOD. NAME														
071128	KHA	KSW	KSW	*	Replacement for Ident.no.:														
SPARES					Type: H21/32														
Info. no. -					Description: STANDARD SPARE PARTS										Ident.no.: B94-030154-8				

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SC13	O-RING 3.53x17.04		VITON (FPM70 SHA)	2/cyl.	2	A15000 -932		DS01/S011
SC14	SEALING RING FOR C/C COVER		NBR	2/cyl.	1	A19300 -384		DS01/S011
SC15	VALVE INSERT -INLET		SCM440	2/cyl.	2	A21100 -111		DS02/S011
SC16	VALVE INSERT -EXHAUST		SCM440	2/cyl.	4	A21100 -112		DS02/S011
SC17	SEALING RING FOR HEAD COVER 285.5x5.33		SIR60 SHA	1/cyl.	1	A21100 -805		DS01/S011
SC18	O-RING 269.3x5.70		VITON (FPM70 SHA)	1/cyl.	2	A21100 -903	for cyl.head	DS01/S011

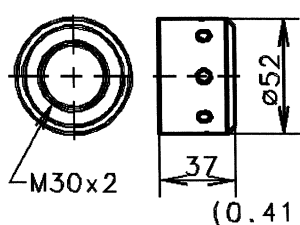
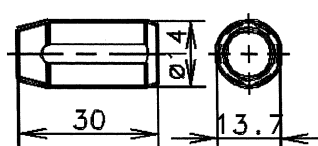
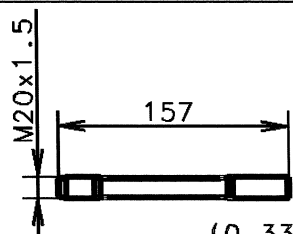
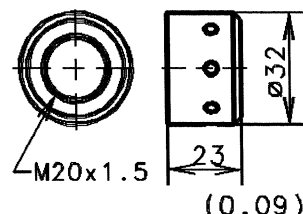
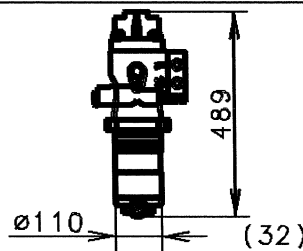
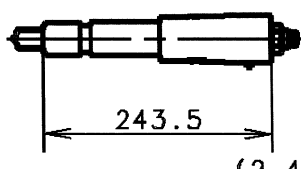
Similar no.:					Ship no.:					Scale:					Mass. (kg):				
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:										R				
				*											G				
				*											4				
080610	UMJ	KSW	KSW	*	MOD.DIMENSION(ITEM SC07)										3				
080229	KGH	KSW	KSW	*	MOD. NAME										2				
080221	UMJ	KSW	KSW	*	MOD. NAME										1				
071128	KHA	KSW	KSW	*	Replacement for Ident.no.:										0				

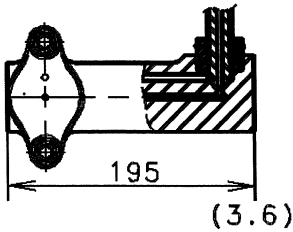
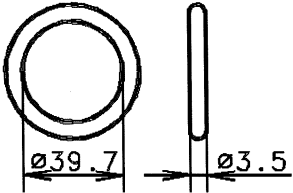
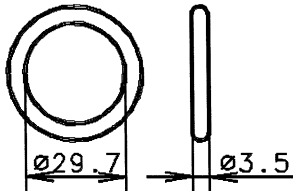
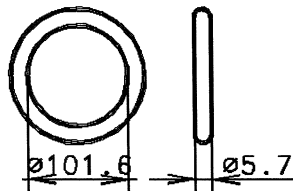
SPARES		Type: H21/32		HYUNDAI HEAVY INDUSTRIES CO., LTD.	
Info. no. -		Description: STANDARD SPARE PARTS		Ident.no.: B94-030154-8	

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.	
SC19	INLET VALVE SPINDLE	 (0.93)	SUH1	2/cyl.	2	A21200 -201		DS02/S011	
SC20	EXHAUST VALVE SPINDLE	 (0.85)	SUH1	2/cyl.	4	A21200 -202		DS02/S011	
SC21	VALVE SPRING (IN./EXH.)	 (0.5)	SWOSC-V	4/cyl.	6	A21200 -203		DS02/S011	
SC22	ROTO CAP	 (0.29)	MAKER	4/cyl.	6	A21200 -204		DS01/S011	
SC23	CONICAL CLAMPING PIECE		SNCM220	4/cyl.	6	A21200 -206		DS01/S011	
SC24	PISTON PIN COMPLETE		Ni-Cr -Mo STEEL	1/cyl.	1	A31100 -120		DS01/S011	
Similar no.:		Ship no.:		Scale:		Mass. (kg):			
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:				R
				*					5
				*					4
080610	UMJ	KSW	KSW	*	MOD. DIMENSION (ITEM SC07)				3
080229	KGH	KSW	KSW	*	MOD. NAME				2
080221	UMJ	KSW	KSW	*	MOD. NAME				1
071128	KHA	KSW	KSW	*	Replacement for Ident.no.:				0
SPARES		Type: H21/32				HYUNDAI HEAVY INDUSTRIES CO., LTD.			
Info. no. -		Description: STANDARD SPARE PARTS				Ident. no.: B94-030154-8			

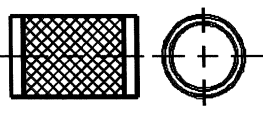
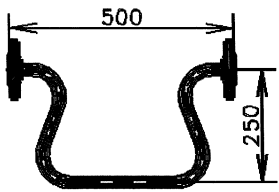
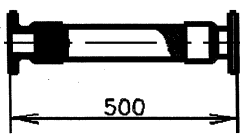
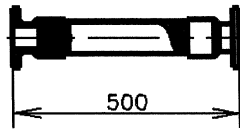
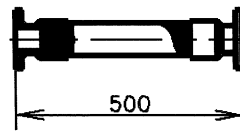
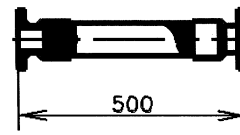
ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SC25	PISTON RING -TOP		MAKER	1/cyl.	1	A31100 -151		DS01/S011
SC26	PISTON RING -2ND		MAKER	1/cyl.	1	A31100 -152		DS01/S011
SC27	OIL SCRAPER RING		MAKER	1/cyl.	1	A31100 -153		DS01/S011
SC28	CONROD BEARING		MAKER	1/cyl.	1	A32000 -120		DS01/S011
SC29	SMLL END BEARING BUSH		MAKER	1/cyl.	1	A32000 -130		DS01/S011
SC30	STUD FOR CON-ROD BIG END M30x2x313		SNCM439	2/cyl.	2	A32000 -191		DS01/S011

Similar no.:					Ship no.:					Scale:					Mass. (kg):				
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:										R				
				*											S				
				*											4				
080610	UMJ	KSW	KSW	*	MOD. DIMENSION (ITEM SC07)										3				
080229	KGH	KSW	KSW	*	MOD. NAME										2				
080221	UMJ	KSW	KSW	*	MOD. NAME										1				
071128	KHA	KSW	KSW	*	Replacement for Ident.no.:										0				
SPARES				Type: H21/32															
Info. no. -				Description: STANDARD SPARE PARTS											Ident. no.: B94-030154-8				

ITEM NO.	NAME	SKETCH (WEIGHT)kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.	
SC31	NUT FOR CON-ROD MBC (M30x2)	 (0.41)	SNCM439	2/cyl.	2	A32000 -192		DS01/S011	
SC32	CYLINDRICAL PIN	 (0.09)	CARBON STEEL	4/cyl.	4	A32000 -193		DS01/S011	
SC33	STUD FOR CON-ROD SHAFT M20x1.5x157	 (0.33)	SNCM439	4/cyl.	2	A32000 -194		DS01/S011	
SC34	NUT FOR CON-ROD SHAFT (M20x1.5)	 (0.09)	SNCM439	4/cyl.	2	A32000 -195		DS01/S011	
SC35	FUEL INJECTION PUMP	 (32)	-	1/cyl.	1	A51000 -100		DS02/S011	
SC36	FUEL INJECTOR NON COOLING	 (2.4)	-	1/cyl.	5H 3 6H 3 7H 4 8H 4 9H 5	A52000 -100		DS01/S011	
Similar no.:		Ship no.:		Scale:		Mass. (kg):			
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:				R
				*					S
				*					4
080610	UMJ	KSW	KSW	*	MOD.DIMENSION(ITEM SC07)				3
080229	KGH	KSW	KSW	*	MOD. NAME				2
080221	UMJ	KSW	KSW	*	MOD. NAME				1
071128	KHA	KSW	KSW	*	Replacement for Ident.no.:				0
SPARES		Type: H21/32				HYUNDAI HEAVY INDUSTRIES CO., LTD.			
Info. no. -		Description: STANDARD SPARE PARTS				Ident. no.: B94-030154-8			

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SC37	FUEL HIGH PRESSURE BLOCK ASSEMBLY		-	1/cyl.	1	A52300 -200		DS01/S011
SC38	O-RING D39.70x3.50		FPM70 SHA	1/cyl.	1	A52300 -116	for H.P. block	DS01/S011
SC39	O-RING 29.70x3.50		FPM70 SHA	2/cyl.	2	A52300 -117	for H.P. block	DS01/S011
SC40	O-RING P102		VITON (FPM70 SHA)	4/cyl.	4	A78000 -712	for cool.water conn.	DS01/S011

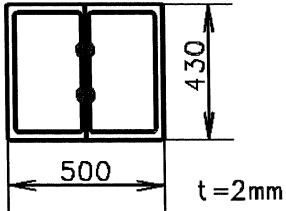
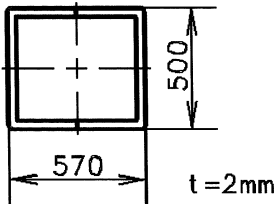
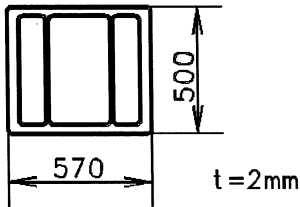
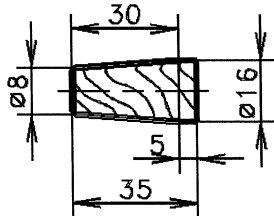
Similar no.:					Ship no.:					Scale:					Mass. (kg):				
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:										R				
				*											5				
				*											4				
080610	UMJ	KSW	KSW	*	MOD.DIMENSION (ITEM SC07)										3				
080229	KGH	KSW	KSW	*	MOD. NAME										2				
080221	UMJ	KSW	KSW	*	MOD. NAME										1				
071128	KHA	KSW	KSW	*	Replacement for Ident.no.:										0				
SPARES				Type: H21/32															
Info. no. -				Description: STANDARD SPARE PARTS											Ident.no.: B94-030154-8				

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SP01	1 ST FILTER (CARTRIDGE)	 (0.5)	ASS'Y	4/eng.	4	A63000-202	for lub. oil	S011
SP02	LOOP EXPAN- SION JOINT Fuel oil in/outlet		ASS'Y	2/eng.	1	A98370-201	16K-25	S011
SP03	METALLIC FLEXIBLE HOSE Waste oil outlet		ASS'Y	1/eng.	1	A98370-206	5K-15	S011
SP04	METALLIC FLEXIBLE HOSE L.O. separator in/outlet Venting to expansion tank		ASS'Y	3/eng.	1	A98370-207	5K-25	S011
OP05	METALLIC FLEXIBLE HOSE Oil vapor discharge		ASS'Y	1/eng.	1	A98370-211	5K-65	S011
SP06	METALLIC FLEXIBLE HOSE Starting air inlet		ASS'Y	1/eng.	1	A98370-213	30K-40	S011

Similar no.:				Ship no.:				Scale:		Mass. (kg):	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:						
				*							
				*							
				*							
				*							
080222	UMJ	KSW	KSW	*	MOD. NAME						
060407	DYJ	JCM	SJR	*	Replacement for Ident.no.:						
SPARES				Type:				H21/32			
Info. no.				Description:				Ident. no.:			
-				STANDARD SPARE PARTS				B94-017626-8			

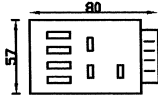
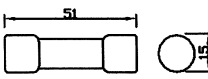
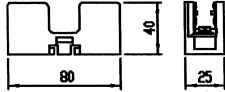
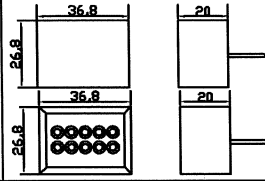
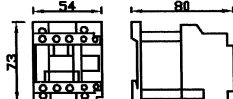
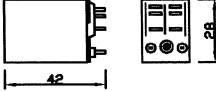
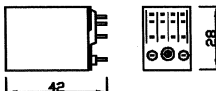
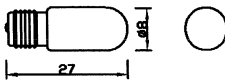
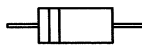
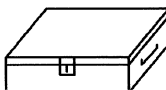


27-2 ~ 2

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAN- DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SC81	GASKET for air cooler		ASBESTOS -FREE	1/eng.	1			S011
SC82	GASKET for air cooler cover		-	1/eng.	1	A84000 -111 For H21/32 C84000 -111 For H25/33		S011
SC83	GASKET for air cooler cover		-	1/eng.	1	A84000 -122 For H21/32 C84000 -122 For H25/33		S011
SC84	WOOD PLUG		WOOD		20			S011
		BLANK						
		BLANK						

Similar no.:B94-014778-5					Ship no.:		Scale:		Mass. (kg):	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:					
				*						
				*						
				*						
				*						
				*						
070214UMJKSWKSW					* Replacement for Ident.no.:					
SPARES					Type:			H21/32 & H25/33		
Info. no.					Description:			Ident. no.:		
-					STANDARD SPARE PARTS (FOR AIR COOLER)			B94-023501-1		



ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAND -ARD SPARE (Q'TY /SHIP	PART NO.	REMARK	BOX NO.	
SE01	ANN.CARD			42	1		ALARM CARD	DS02/ S011	
				3	1		COMMON CARD		
SE02	FUSE			30	30		1A	DS02/ S011	
				8	6		3A		
				20	20		5A		
				2	2		20A		
				2	2		25A		
SE03	FUSE HOLDER			62	6		FH-30	DS02/ S011	
SE04	LED FOR IND. LAMP			3	1		YSBRL34-DL24-W	DS02/ S011	
				3	1		YSNRL34-DL24-G		
				12	2		YSBRL34-DL24-Y		
				56	5		YSNRL34-DL24-R		
SE05	MAGNETIC CONTACTOR			3	1		HiMC22W11 AC220V	DS02/ S011	
				3	1		HiMC32W22 AC220V		
SE06	RELAY			33	3		SZR-LY4-N1 (DC24V)	DS02/ S011	
				12	1		SZR-LY2-N1 (DC24V)		
SE07	RELAY			130	10		SZR-MY4-N1 (DC24V)	DS02/ S011	
SE08	BULB			12	12		E-10,24V,1W	DS02/ S011	
SE09	FUSE PULLER			1	1		pf-36	DS02/ S011	
SE10	DIODE			58	5		1N5408	DS02/ S011	
SE11	BOX				1			DS02/ S011	
Similar no. :		Project : Yangfan 2003~2008			Scale :		Mass.(kg)		
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:				R
				*					5
				*					4
				*					3
				*					2
090828	JHK	KSJ	KSR	*	Change hull no.				1
071212	JHK	JCM	SJR	*					0
Licensor Ident.No.:		Type:			5H21/32				
SPARE		Description:				Ident.no.:			
Page.no.:		01 OF 01				B94-029866-9			
		SPARE PARTS FOR LOCAL CONTROL PNAEL WITH PUMP STARTER AND J.W PREHEATER STARTER							

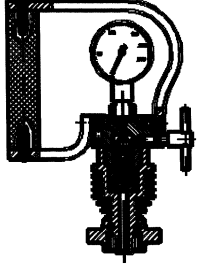
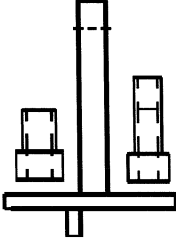
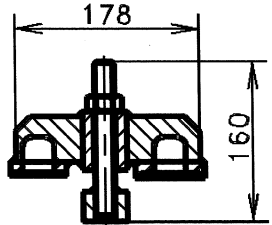
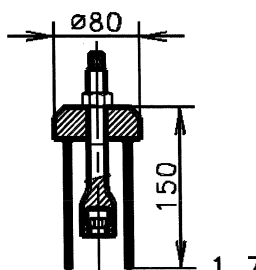
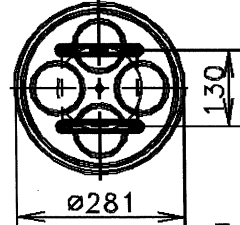
[illegible]

PLAN HISTORY	ENGINE TYPE	HYUNDAI-HIMSEN 3x5H21/32x900rpm
	MESSRS	Yangfan Group Co., Ltd.
	RULE	ABS
	PROJECT	Yangfan2003/4/5/6/7/8
	ENG. NO.	BA2768/69/70/71/72/73

TITLE: LIST OF TOOL PARTS FOR D/G ENGINE

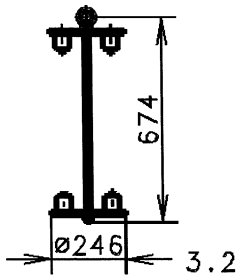
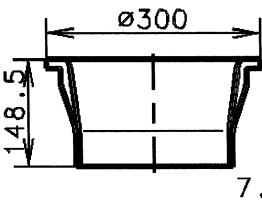
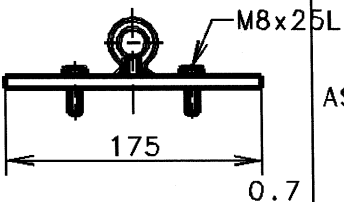
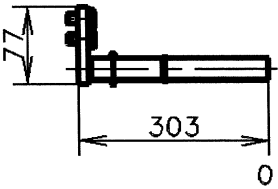
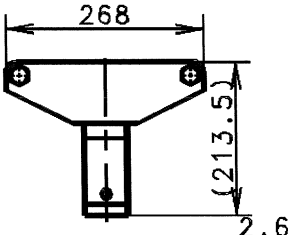
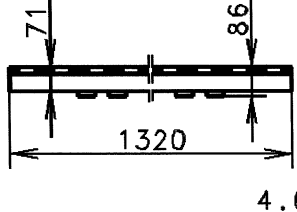
1. STANDARD TOOL PARTS ----- B94-032942-2.0
(ST-9-1~ST-9-9)
2. STANDARD TOOL PARTS ----- B94-016401-5.1
(ST-9-9-1)
3. STANDARD TOOL PARTS ----- B94-016404-0.4
(ST-9-9-2)
4. STANDARD TOOL PARTS FOR A/C ----- B14-153492-8.2
(ST-1-1)
5. LIFTING TOOL PARTS ----- B94-026338-2.2
(XT-1-1) (FOR THE FIRST SHIP ONLY)

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
090827	JYS	KCS	KBY	*	Changed hull no.	2
080731	KGM	KSR	KSR	*	Revised no.1,2,3,5	1
071211	KGM	KSR	KSR	*	Replacement for Ident.no.:	0
Licensor Ident.no.:				Type:	5H21/32	
Info.no.:				Description:	LIST OF TOOL PARTS	
Page.no.:						
1 OF 13						B94-030434-0

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST01	MAX. PRESSURE INDICATOR	 3.8	MAKER	1	91.100		DT01/S011
ST02	LIFTING TOOL for cyl. head		ASS'Y	1	91.110		DT01/S011
ST03	FIT/REMOVAL DEVICE for v/v con piece	 3.65	ASS'Y	1	91.120		DT01/S011
ST04	REMOVAL DEVICE for injection valve	 1.7	ASS'Y	1	91.130		DT01/S011
ST05	GRINDING TOOL for cyl. head /liner	 7.5	ASS'Y	1	91.140		DT01/S011

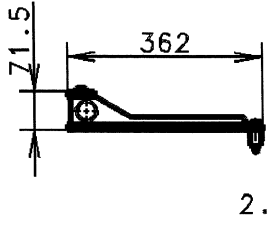
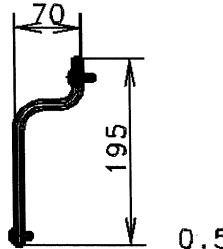
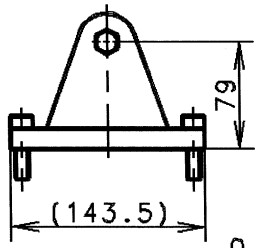
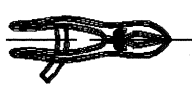
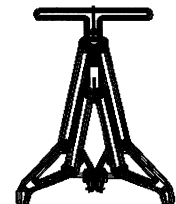
Similar no.:-		Ship no.:-		Scale: -		Mass. (kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident. no.:		
000000		STANDARD TOOL PARTS			B94-032942-2		



ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST06	EXTRACT/ SUSPENSION DEV. for cyl. liner		ASS'Y	1	91.150		DT01/S011
ST07	PISTON GUIDE		ASS'Y	1	91.160		DT02/S011
ST08	PISTON LIFTING		ASS'Y	1	91.170		DT01/S011
ST09	HOLDING PIECE for crank pin bearing		ASS'Y	1	91.180		DT01/S011
ST10	SUSPENSION DEV. for crank pin bearing		ASS'Y	1	91.190		DT01/S011
ST11	GUIDE SUPPORT		WOOD	1	91.200	for con-rod	S011

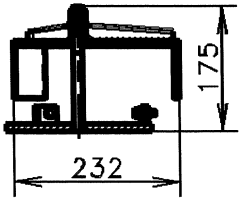
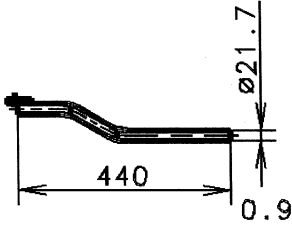
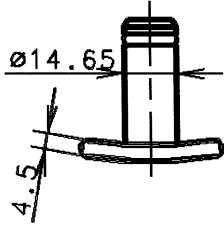
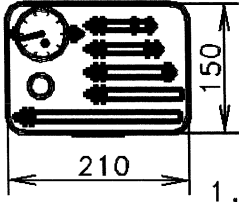
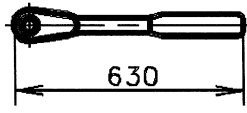
Similar no.:-		Ship no.:-		Scale: -		Mass.(kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident.no.:		
000000		STANDARD TOOL PARTS			B94-032942-2		



ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST12	TURNING BRACKET for con-rod		ASS'Y	1	91.210		DT01/S011
ST13	CLAMPING SUPPORT for con-rod		SS400	2	91.220		DT01/S011
ST14	SUSPENSION for con-rod & piston		ASS'Y	1	91.230		DT01/S011
ST15	PLIER 85	 1.45	MAKER	1	91.240		DT01/S011
ST16	PISTON RING OPENER	 0.47	MAKER	1	91.250		DT01/S011
ST17	CYLINDER BORE GAUGE	 (200 ~225) 0.2	MAKER	1	91.260		DT01/S011

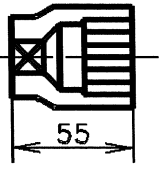
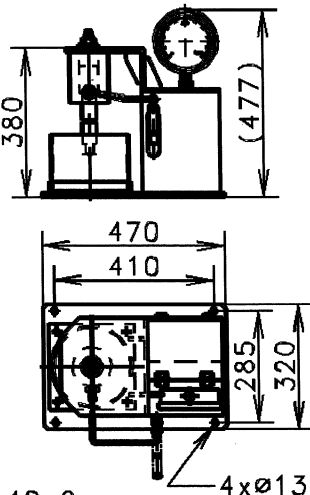
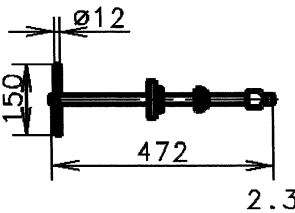
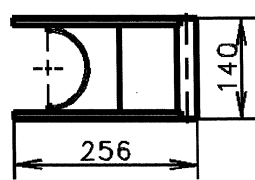
Similar no.:-		Ship no.:-		Scale: -		Mass. (kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
				*			
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident. no.:		
000000		STANDARD TOOL PARTS			B94-032942-2		



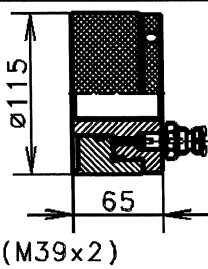
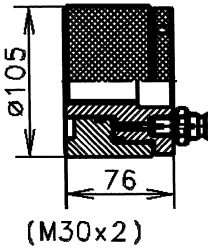
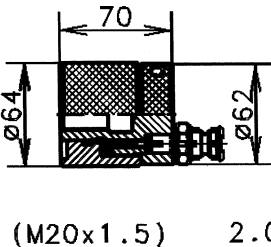
ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST18	REMOVAL DEVICE for flame ring		MAKER	1	91.270		DT01/S011
ST19	FEELER GAUGE (0.5T)	 0.1	MAKER	1	91.280		DT01/S011
ST20	LIFTING DEVICE for M.B.C.		ASS'Y	4	91.290		DT01/S011
ST21	FITTING DEVICE for main bearing	 0.1	ASS'Y	1	91.300		DT01/S011
ST22	CRANKSHAFT DEFLECTION GAUGE		MAKER	1	91.310		DT01/S011
ST23	SPANNER 3/4		MAKER	1	91.320	for turning gear	DT01/S011

Similar no.:-		Ship no.:-		Scale: -		Mass.(kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
				*			
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident. no.:		
000000		STANDARD TOOL PARTS			B94-032942-2		



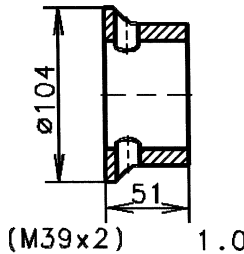
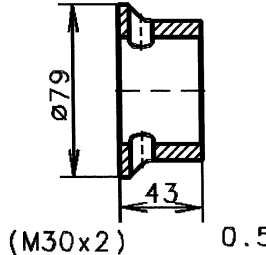
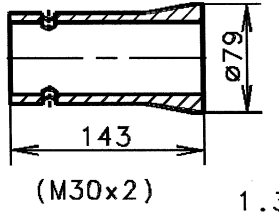
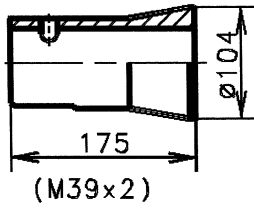
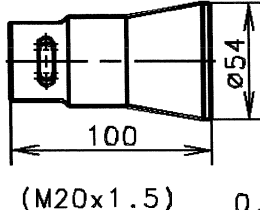
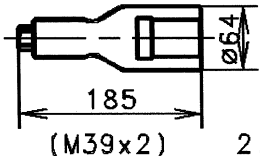
ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST24	EXTENSION BAR 24	 0.1	MAKER	1	91.330		DT01/S011
ST25	NOZZLE TESTER	 40.2	ASS'Y	1	91.340		S011
ST26	LAPPING DEVICE for inj. valve bush	 2.3	ASS'Y	1	91.350		DT01/S011
ST27	CLEANING TOOL for fuel inj. nozzle	 0.1	MAKER	1	91.370		DT01/S011
ST28	REMOVAL DEVICE (C.W. connection)		ASS'Y	1	91.380		DT01/S011

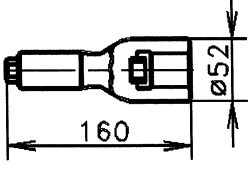
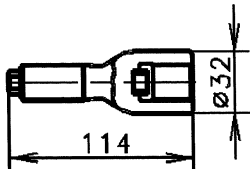
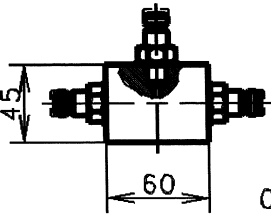
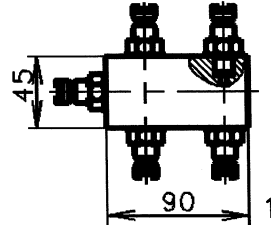
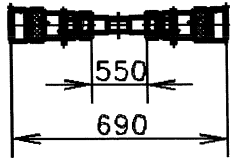
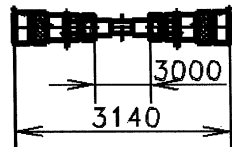
Similar no.:-		Ship no.:-		Scale: -		Mass. (kg): -		
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:			R
				*				5
				*				4
				*				3
				*				2
				*				1
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3			0
TOOLS		Type:			H21/32			
Info. no. 000000		Description:			STANDARD TOOL PARTS			
					Ident. no.:			B94-032942-2

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST29	HYDRAULIC JACK M39X2	 (M39x2) 3.9	ASS'Y	4	91.400		DT02/S011
ST30	HYDRAULIC JACK M30X2	 (M30x2) 4.5	ASS'Y	2	91.410		DT02/S011
ST31	HYDRAULIC JACK M20X1.5	 (M20x1.5) 2.0	ASS'Y	2	91.420		DT02/S011
ST32	SET OF SPARE PARTS for hyd. jack M39	O-RING:2 BACK-UP RING:2 QUICK COUPLING	MAKER	1	91.430		DT01/S011
ST33	SET OF SPARE PARTS for hyd. jack M30	O-RING:2 BACK-UP RING:2 QUICK COUPLING	MAKER	1	91.440		DT01/S011
ST34	SET OF SPARE PARTS for hyd. jack M20	O-RING:2 BACK-UP RING:2 QUICK COUPLING	MAKER	1	91.450		DT01/S011

Similar no.:-		Ship no.:-		Scale: -		Mass.(kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
				*			
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident.no.:		
000000		STANDARD TOOL PARTS			B94-032942-2		

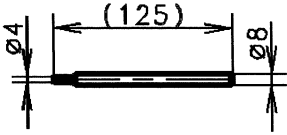
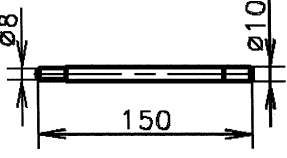
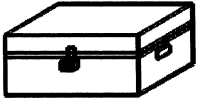
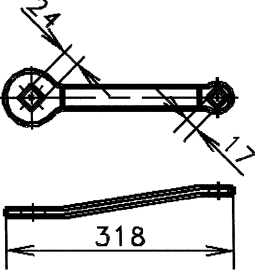
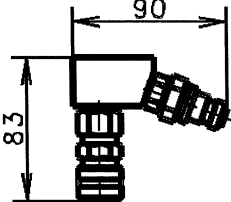


ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.	
ST35	SUPPORT for M.B.C. (M39x2)	 (M39x2) 1.0	SNCM439	2	91.460		DT01/S011	
ST36	SUPPORT for hydr. jack (M30x2)	 (M30x2) 0.5	SNCM439	2	91.470		DT01/S011	
ST37	SUPPORT for hyd. jack (M30x2)	 (M30x2) 1.3	SNCM439	2	91.480		DT01/S011	
ST38	SUPPORT for cylinder head	 (M39x2) 4	SNCM439	4	91.490		DT01/S011	
ST39	SUPPORT for con. shaft (M20x1.5)	 (M20x1.5) 0.6	SNCM439	2	91.500		DT01/S011	
ST40	EXTENSION SCREW for cyl. head	 (M39x2) 2.5	SNCM439	4	91.510		DT01/S011	
Similar no.:-		Ship no.:-		Scale: -		Mass. (kg): -		
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:			R
				*				S
				*				4
				*				3
				*				2
				*				1
080430/KGM/KSR/KSR		*	Replacement for Ident.no.:			B94-016400-3		0
TOOLS		Type:			H21/32			
Info. no.		Description:			Ident. no.:			
000000		STANDARD TOOL PARTS			B94-032942-2			

ITEM NO.	NAME	SKETCH (WEIGHT)kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST41	EXTENSION SCREW for c/ weight, flywheel	 (M30x2) 1.5	SNCM439	2	91.520		DT01/S011
ST42	EXTENSION SCREW for con-rod shaft	 (M20x1.5) 0.4	SNCM439	2	91.530		DT01/S011
ST43	DISTRIBUTOR PIECE (2-pot)	 0.7	ASS'Y	1	91.541		DT01/S011
ST44	DISTRIBUTOR PIECE (4-pot)	 1.0	ASS'Y	1	91.542		DT01/S011
ST45	HIGH PRESSURE HOSE L=550	 1.7	ASS'Y	4	91.551		DT01/S011
ST46	HIGH PRESSURE HOSE L=3000	 1.7	ASS'Y	1	91.552		DT01/S011

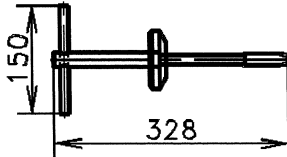
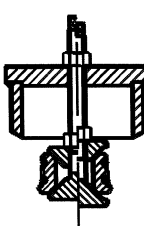
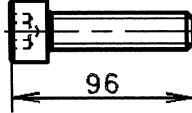
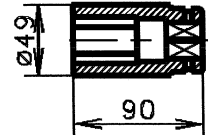
Similar no.:-		Ship no.:-		Scale: -		Mass.(kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident.no.:		
000000		STANDARD TOOL PARTS			B94-032942-2		



ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST47	TURNING PIN		MAKER	2	91.600		DT01/S011
ST48	PIN		MAKER	2	91.610		DT01/S011
ST49	SPARE & TOOL BOX	 (800x400x300) 5.0	CARBON STEEL	4	91.640		S011
ST50	TURBOCHARGER CLEANING HOSE	 Rubber hose 20M with reducing V/V 5.26		1	98.100		DT02/S011
ST51	TOOL for lub./fuel oil filter			1	98.200		DT01/S011
ST52	ANGLE PIECE		MAKER	2	91.421	for hydraulic jack M20x1.5	DT01/S011

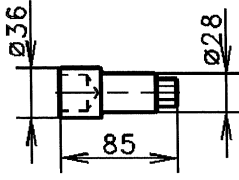
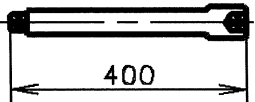
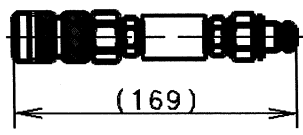
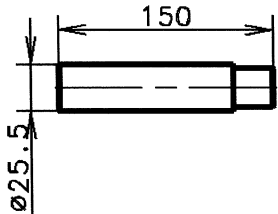
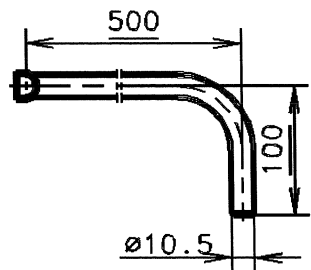
Similar no.:-		Ship no.:-		Scale: -		Mass.(kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
				*			
080430/KGM/KSR/KSR				*	Replacement for Ident.no.: B94-016400-3		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident.no.:		
000000		STANDARD TOOL PARTS			B94-032942-2		



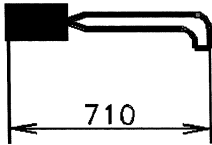
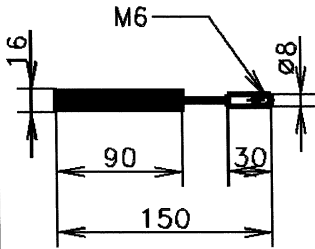
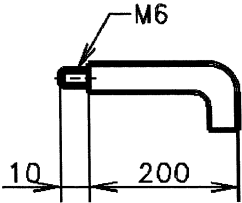
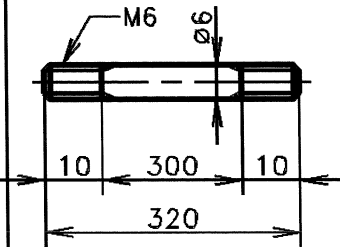
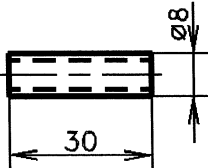
ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	GENE- RAL TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST61	LAPPING DEVICE for in/exh. v/v seat		-	1	91.360		DT01/S011
ST62	REMOVAL DEVICE for exh. valve seat		-	1	91.580		DT01/S011
ST63	NOZZLE REMOVING TOOL (H21/32)		-	1	91.390		DT01/S011
ST64	SOCKET HEAD BOLT M10		-	2	91.933		DT01/S011
ST65	TOOL for H21/32 nozzle		-	1	91.630	for F.O. pump nozzle nut	DT01/S011
ST66	ENGINE CLEANER		-	1	91.620		DT01/S011

Similar no.:-		Ship no.:-		Scale: -		Mass. (kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
080216	KGM	KSR	KSR	*	CHANGED NAME		
060209	HSK	KSW	KSW	*	Replacement for Ident.no.:		
TOOLS		Type:			H21/32		
Info. no.		Description:			Ident. no.:		
000000		STANDARD TOOL PARTS			B94-016401-5		



ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	GENE- RAL TOOL (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
ST71	T/V DAMPER TOOL		31CrV3W	1	91.930		
ST72	EXTENSION BAR 20		31CrV3W	1	91.931	for T/V damper	
ST73	ADAPTER for hyd. handing pump		-	1	91.590		
ST74	REMOVAL DEVICE for fuel valve bush		ASS'Y	1	91.720		DT01/S011
ST75	REMOVAL TOOL -locking ring		ASS'Y	1	91.940		DT01/S011

Similar no.:-		Ship no.:-		Scale: -		Mass.(kg): -	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
080522	KGM	KSR	KSR	*	Mod.sketch item ST73		
080216	KGM	KSR	KSR	*	CHANGED NAME		
070928	HSK	KSR	KSR	*	ADDED ITEM ST74,75		
060918	HSK	KSW	KSW	*	DEL.BOX NO.		
060209	HSK	KSW	KSW	*	Replacement for Ident.no.:		
TOOLS				Type:	5, 6, 7H21/32		
Info. no.		Description:		Ident.no.:			
000000		STANDARD TOOL PARTS		B94-016404-0			

ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	STAN- DARD TOOL (Q'TY /SHIP)	PLATE- ITEM NO.	REMARKS	BOX NO.
ST81	NYLON BRUSH		NYLON& SS400	1		THIS TOOL TO BE ASSEMBLED WITH ST82,83,84,85	DT01/S011
ST82	NYLON BRUSH		NYLON& SS400	1			DT01/S011
ST83	HANDLE		SS400	1			DT01/S011
ST84	BAR		SS400	1			DT01/S011
ST85	JOINT		SS400	2			DT01/S011
		BLANK					

Similar no.:		Ship no.:		Scale:		Mass. (kg):	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:		
				*			
				*			
				*			
				*			
060928	JSC	KSR	SJR	*	Changed description		
060126	JSC	KSR	SJR	*	Modified remark		
050610	HSK	KSW	KSW	*	Replacement for Ident.no.:		
Type:				ALL			
Info. no.				Description:		Ident. no.:	
				STANDARD TOOL PARTS FOR AIR COOLER		B14-153492-8	



ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	EXTRA TOOL (Q'TY /SHIP)	PART NO.	REMARKS	PLATE NO.
XT01	LIFTING BEAM			1	-		
XT02	EXTENSION SCREW for lifting			8	-		
XT03	NUT M39			8	-		

Lifting tool is not included in tool box but attached on engine

Similar no.:					Ship no.:-					Scale:		Mass. (kg):	
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:							R	
				*								5	
				*								4	
				*								3	
080308	KGM	KSR	KSR	*	REVISED SKETCH XT01							2	
080214	KGM	KSR	KSR	*	CHANGED NAME							1	
071101	HSK	KSR	KSR	*	Replacement for Ident.no.:							0	
TOOLS				Type:		H21/32							
Info. no.				Description:		LIFTING TOOL PARTS					Ident. no.:		
000000											B94-026338-2		

PLAN HISTORY					ENGINE TYPE	HYUNDAI-HIMSEN 3 x 5H21/32 x 900 rpm		
$\triangle$ 1 MESSRS					Yangfan Group Co.,Ltd			
					ABS			
					$\triangle$ 1 PROJECT		Yangfan2003~2008	
					$\triangle$ 1 ENG. NO.		BA2768-2773	
TITLE : GENERATOR								
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	R		
				*		5		
				*		4		
				*		3		
20090827	KGH	KJC	KBY	*	Changed hull no.	2		
20080812	YYC	YYC	KJC	*	For working	1		
20071210	KJC	KJC	KKS	*		0		
Similar drawing No.:					Replacement for Ident. No.:			
Licensor Ident. No.:				Type: -				
Info. No.:								
Page. No.: 01 OF 17				Description: GENERATOR		Ident.no.: B94-026013-9		

CUSTOMER : YANGFAN SHIPYARD
PROJECT NAME : YANGFAN 2003-8
REFERENCE NO. : APP-07RAL574-Rev.1
DATE ISSUED : Aug. 11, 2008
CLASS : ABS

SPECIFICATION for **SYNCHRONOUS GENERATOR** (1125 KVA, 8P, 450V, 60Hz, 3SETS)

FOR WORKING

1	Aug. 11, 2008	For Working	H.S.JUNG	-	O.S.SONG	H.W.KIM
0	Dec. 11, 2007	For Approval	H.S.JUNG	S.M.LEE	O.S.SONG	D.S.KIM
Rev.	Date Issued	Contents	Prepared by	Checked by	Checked by	Approved by

(TEL:82-52-202-6904, FAX:82-52-202-6995)

▲ HYUNDAI HEAVY INDUSTRIES CO., LTD

Electro Electric Systems

<http://www.hhi.co.kr>

CONTENTS

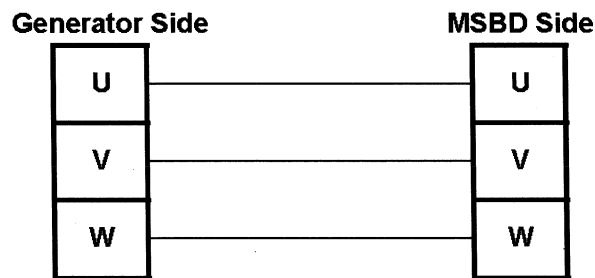
1	CAUTION	
2	SPECIFICATION OF GENERATOR	: HFC7 506-84K-Rev.1
3	PROCEDURE OF A.C GENERATOR TEST	: MG TA 1
4	SECTIONAL DRAWING	: 3G-003022-Rev.0
5	OUTLINE OF GENERATOR	: 3H-000019-Rev.3
6	DIMENSION OF SHAFT	: 3H-000020-Rev.1
7	TERMINAL BOX ASS'Y	: 3G-001777-Rev.1
8	AVR CONNECTION DIAGRAM	: 3G-002029-Rev.0
9	TERMINAL CONNECTION DIAGRAM	: 3G-002055-Rev.1
10	DROOP CHARACTERISTIC...	: 4G-000175-Rev.0
11	REFERENCE VALUE SETTER	: 3M-053674-Rev.0
12	SPARE PART FOR A.C GENERATOR	: 4M-023970-Rev.0
13	D/G SET PLAN VIEW	: 4M-057762-Rev.1

CAUTION

A. Phase Sequence

Phase sequence of these generators are U→V→W regardless of rotating direction of prime mover.

Please connect all cables as shown in below figure 1.



※ MSBD : Main Switch Board
< Figure 1 >

B. Manual Synchronizing

Please be careful at synchronizing of each generator during on board test or normal operating as follows.

- 1) Check that incoming generator voltage level and frequency in its no-load condition is correct.
- 2) After rotating the synchronizing switch to the "ON" position, please check the condition of the synchroscope pointer, and adjust the speed of the incoming Engine/Generator until it is rotating slowly to clockwise direction (no more than 1 revolution / 20 seconds).
- 3) The incoming generator breaker should be closed as close to the 12 o'clock position as possible.

Warning

If generator breaker is closed at conditions other than the above, the generator excitation system (Diodes, Varistors, Transformer ...) & rotor or stator can be damaged by transient reactive current.

[2008-08-11]

SPECIFICATION OF GENERATOR

USE		DIESEL ENGINE GENERATOR		QUANTITY / SHIP		3ST / SHIP		
TYPE OF ENCLOSURE		IP 23		APPLIED CLASS		ABS		
COOLING SYSTEM		AIR TO AIR		AMBIENT TEMP.		50 ℃		
EXCITING SYSTEM		SELF EXCITING BRUSHLESS		INSULATION CLASS		F		
STRUCTURE OF ROTOR		CYLINDRICAL ROTOR		TEMPERATURE RISE		F		
COUPLING METHOD		DIRECT DISK COUPLING		APPLIED UNIT		METRIC		
SPECIFICATION				BEARING				
TYPE		HFC7 506-84K		TYPE OF BEARING		SLEEVE BEARING		
OUTPUT CAPACITY		1125.0 KVA		LOCATION		DRIVED END NON-DRIVED END		
RATING		CONTINUOUS		SIZE		- Φ100*L120		
PHASES,WIRE,CONN		3 Φ, 3 W, Y (DAMPER WINDING)		OIL QUANTITY		- 2.3 LITER		
VOLTAGE		AC 450 V		LUB SYSTEM		- SELF LUB.		
CURRENT		1443.4 A		OIL GRADE		ISO VG 32		
FREQUENCY		60 Hz		INLET PRESSURE		- bar		
POLES		8 P		INLET TEMP.		Max - ℃		
SPEED		900 RPM		AIR COOLER				
POWER FACTOR		0.8 LAGGING		CAPACITY		-		
GD ² / J		293.6 Kg.m ² / 73.4 Kg.m ²		FLUID		-		
ROTOR WEIGHT		1700 Kg		QUANTITY		- m ³ /h		
TOTAL WEIGHT		4.3 ton		INLET TEMP.		- ℃		
CHARACTERISTICS				TEMP RISE		- ℃		
OVER CURRENT		REFER TO ITP		PRESSURE DROP		- Kg/cm ²		
VARIATION OF GENERATOR VOLTAGE		±2.5 %		DRY WEIGHT		- Kg		
OVER SPEED		120 % / 2 min.		DETECTING SYSTEM				
VOLTAGE ADJUST		±5.0 %		WINDING TEMP.		PT100 OHM × 2EA/PHASE		
MOUNTING METHOD		B5/B20		BEARING TEMP.		ROD TYPE + PT100OHM x 1EA/BRG.		
REACTANCE & TIME CONSTANT (CALCULATED VALUE)				COOLING AIR TEMP		-		
				LEAKAGE DETECTOR		-		
Xd	345 %(UNSATURATED)	T' d	0.0703 Sec.	CONFIRMED ITEM BY OWNER				
X' d	22 %(SATURATED)	T'' d	0.0028 Sec.	* LOCATION OF TERMINAL BOX. (VIEWD FROM PRIME MOVER)		ALL RIGHT SIDE ⚠		
X'' d	13 %(SATURATED)	Ta	0.0202 Sec.	* CABLE ENTRY		ALL TOP SIDE ⚠		
ra	1.9 %			* SPACE HEATER		1PH, AC 220V. 315W		
NOTE				* PAINTING COLOR		7.5 BG 7/2		
* WTD - ALARM : 150℃ - TRIP : 155℃ * BTD - ALARM : 90℃ - TRIP : 95℃				* LOCATION OF AIR COOLER FLANGE (VIEWD FROM PRIME MOVER)		C.C.W		
				* ROTATING DIRECTION OF GENERATOR (VIEWD FROM PRIME MOVER)				
								REMARK
REV	CONTENTS		DATE	1.THE SPECIFICATION OF * MARK SHOULD BE INFORMED ON YOUR APPROVED DRAWING				
1								
2				HFC7 506-84K-Rev.1				
3				DATE	DESIGN	CHECKED	CHECKED	APPROVED
4				Dec. 11, 2007	H.S.JUNG	-	O.S.SONG	H.W.KIM
5								

RW-W230-158-0

A4(210mm X 297mm)

TEST PROCEDURE OF A.C SYNCHRONOUS GENERATOR			MG TA 1	1 / 2
No	Test Item	Procedure	Criterion	Remarks
1	Temperature Rise Test	The generator will be operated with rated current until the temperature of each section are saturated according to IEEE115. Temperature rise of each winding will be measured by resistance method.	Stator : < 95 °C Rotor : < 100 °C	Type Test
2	Overcurrent Test	The generator will have to withstand 50% excess of rated current for 30 seconds after temperature rise test.	Without damage visually	Type Test
3	Overspeed Test	Overspeed test will be carried out for 120 seconds with 1.2 times the rated speed under no excitation condition.	Without damage visually	
4	Dielectric Strength Test	The test voltage with commercial frequency will be applied to each winding for 60 seconds.	Stator : 2,000 V Rotor : 1,500 V	
5	Measurement of Insulation Resistance	Insulation resistance of each separate winding will be measured with DC megger before and after high voltage test.	More than 5MΩ	
6	Measurement of Winding Resistance	Each winding resistance will be measured by volt-ampere method.		
7	Verification of the voltage regulation system	The generator, together with its voltage regulation system, will be verified in such a way that, at all loads from no-load running to full load, the rated voltage at the rated power factor is maintained within ±2.5% under steady condition. Test shall be carried out at zero (0) factor load according to approval drawing.		

TEST PROCEDURE OF A.C SYNCHRONOUS GENERATOR			MG TA 1	2 / 2
No	Test Item	Procedure	Criterion	Remarks
8	Steady State Short Circuit Test	After power circuits are shorted with no excitation, giving excitation while running at rated revolution, the generator with excitation systems will have to withstand 300% rated current for 2 seconds.	Without damage visually	Type Test
9	Momentary Voltage Variation Test	The momentary voltage variation shall be measured and calculated by equivalent method of JEM(Japanese Electrical Manufacturer's Association) 1354. The equivalent calculation method are as follows. $\Delta V = \frac{V - V_{min}}{V - V_{min} + (I_s \times X_e) / 100} \times 100 (\%)$ V : Rated Voltage (%) Vmin : Minimum Voltage when applying the load (%) Is : Load Current in Vmin (%) Xe : Impedance of applied load (%) * The recovery time within $\pm 3.0\%$ of the rated voltage shall be checked during engine's governor characteristic test at engine's shop.	Less than 15% of rated voltage, at least 60% of the rated current of generator with power factor of 0.4 lagging or less.	Type Test
10	Verification of Bearing	Upon completion of the test, the bearing shall be overhauled.	Without damage visually	
11	Air Gap Measurement	Measurement record to be submitted to the surveyor.		
12	Running Balance Test	Generator will be operated at no load and rated speed. The vibration of the machine and operation of the bearing lubrication system will be checked.		

※1. Type Test : Test of the first generator of a series.

Rev.2

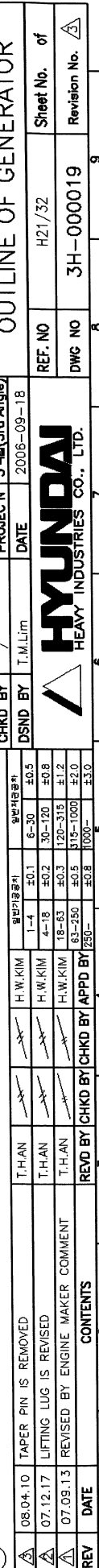
※2. Above test items & procedure are satisfied with ABS requirement.



THIS DRAWING DEFINES GENERAL CONCEPT OF GENERATOR,
THIS DRAWING DEFINES GENERAL CONCEPT OF GENERATOR,
THIS DRAWING DEFINES GENERAL CONCEPT OF GENERATOR,

[illegible]

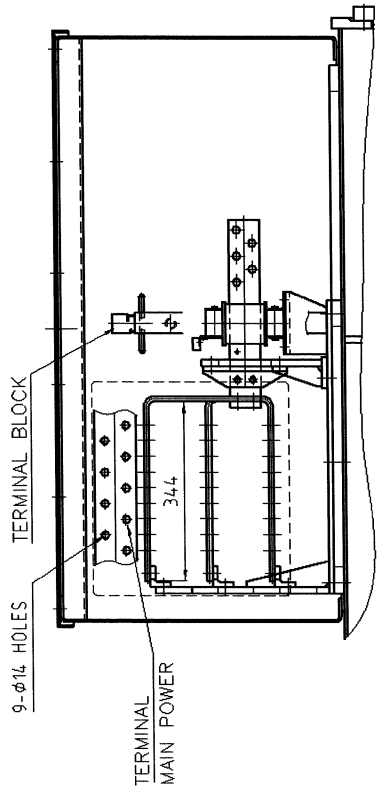
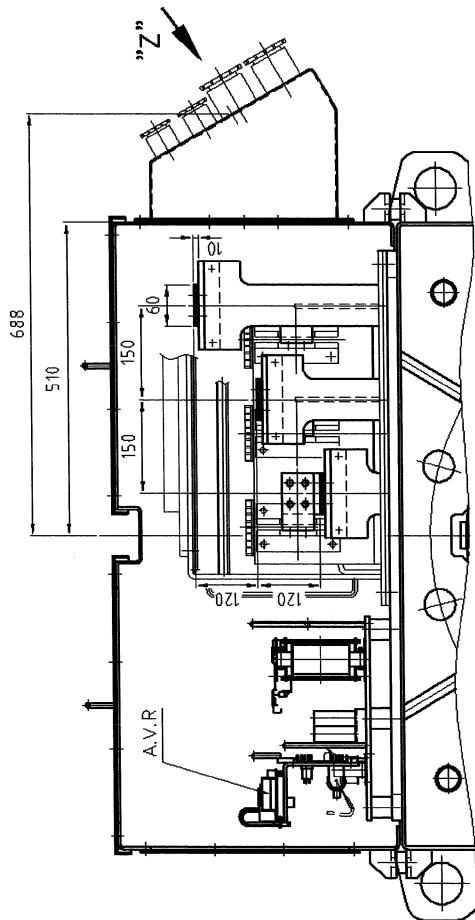
QTY		DESCRIPTION		MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	H.W.KIM	UNIT		MM	SUBJECT			CAD PROJ. # \ FILE #	
Q.P. CHK	X	SCALE	N/S		SECTIONAL DRAWING				
CHKD BY		PROJEC'TN	3 次 (3rd Angle)						
DSND BY	H.S.JUNG	DATE	2007.5.31						
				REF. NO.		Sheet No.		of	
HYUNDAI HEAVY INDUSTRIES CO., LTD.				DWG NO		3G-003022		Revision No. 	



DIMENSION OF SHAFT : 3H-000020-Rev.1



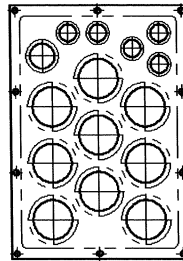
HYUNDAI
HEAVY INDUSTRIES CO., LTD.



N-D.E

D.E

NOTE	CABLE SIZE	Q'TY	CABLE GLAND
FOR MAIN POWER	$\phi 47$ mm	9	55B
FOR REFERENCE VALUE SETTER	$\phi 19$ mm	1	25C
FOR W.T.D	$\phi 29$ mm	1	35B
FOR B.T.D	$\phi 16$ mm	1	25A
FOR VOLTAGE SENSING	$\phi 16$ mm	1	25A
FOR PRE-EXCITING	$\phi 16$ mm	1	25A
FOR SPACE HEATER	$\phi 16$ mm	1	25A

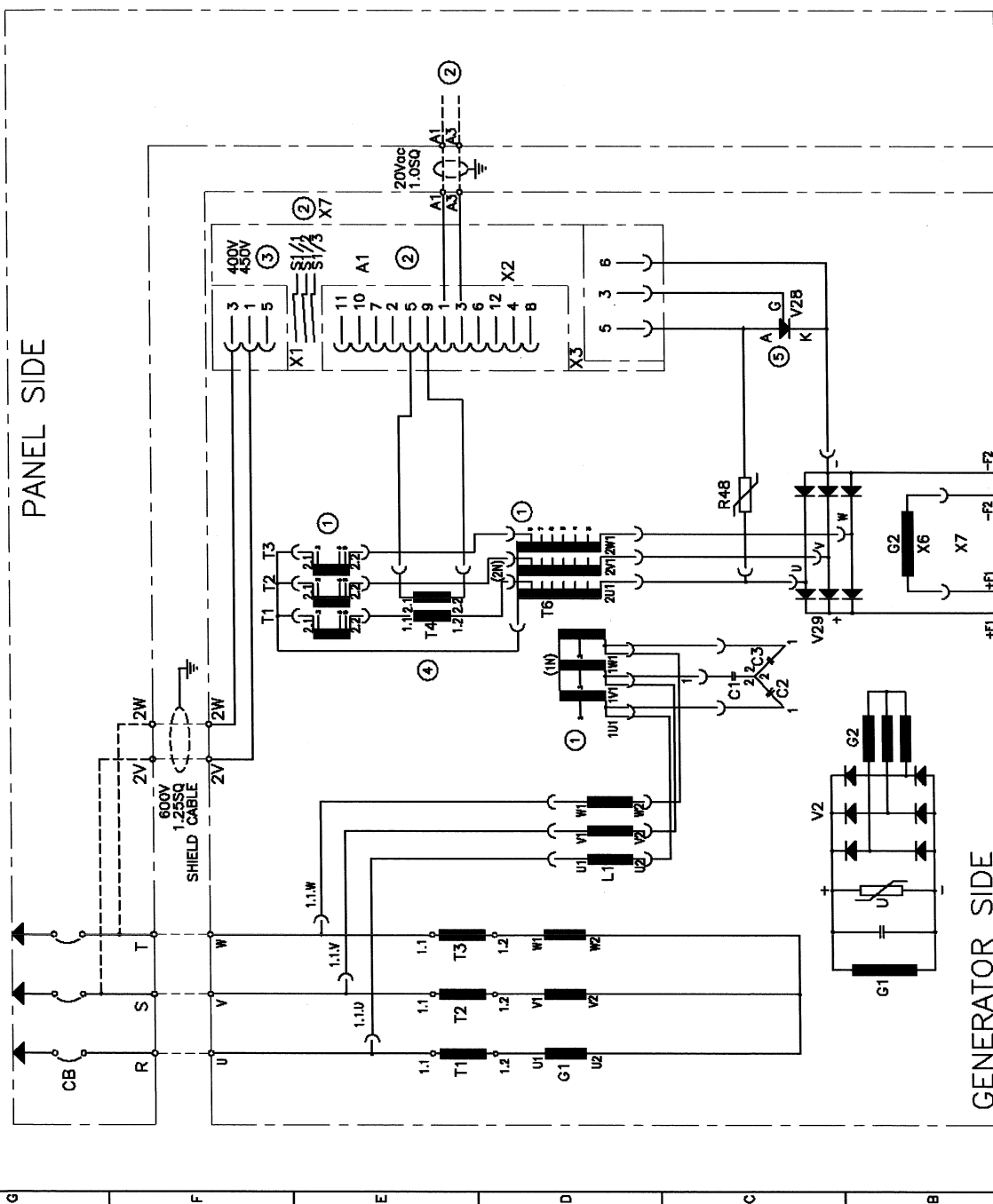


* CORE OF MAIN POWER CABLE GLAND TO BE USED 3C CABLE FOR 3 PHASE.

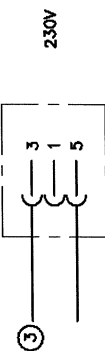
▽ 50S																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
-------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

PANEL SIDE

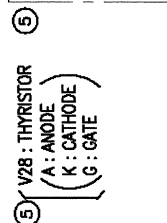
GENERATOR SIDE



- ① CONNECTIONS ARE DETERMINED IN THE TEST FIELD.
- ② WHEN REFERENCE VALUE SETTER FITTED
CIRCUIT BREAKER S1/3 OFF
REFERENCE VALUE
SETTER (VR)



- A1 : VOLTAGE REGULATOR
C1...C3 : CAPACITOR
G1 : MAIN MACHINE
G2 : EXCITER
L1 : REACTOR
T1...T3 : CURRENT TRANSFORMER
T4 : CURRENT TRANSFORMER FOR DROOP COMP.
T6 : RECTIFIER TRANSFORMER
V2 : ROTATING RECTIFIER
X1...X4 : PLUG CONNECTION
X6...X7 : TERMINAL STRIP
V28 : RECTIFIER MODULE
R48 : BY-PASS RESISTOR
④ CURRENT TRANSFORMER FOR DROOP COMP.
NECESSARY FOR PARALLEL OPERATION
U : VARISTOR
S : SPACE HEATER



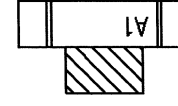
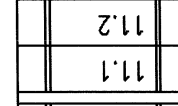
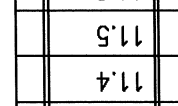
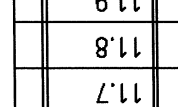
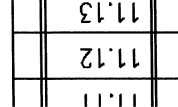
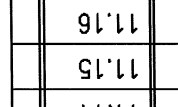
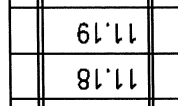
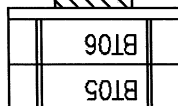
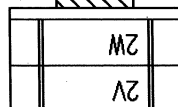
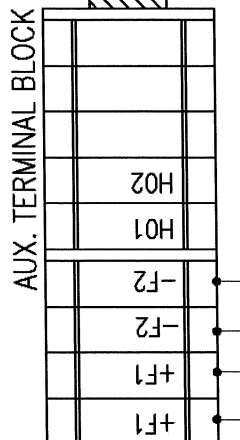
** NOTE
1. IF NECESSARY, APPLY FIELD FLASHING CIRCUITRY USING DC POWER
(NOT MORE THAN 24Vdc).
THE FIELD FLASHING CIRCUITRY SHOULD BE OFF IF VOLTAGE BUILD-UP
RELAY IS ACTUATED AFTER FIELD FLASHING.
THIS CIRCUITRY SHOULD BE SUPPLIED BY SWITCH BOARD MAKER.

Q'TY	DESCRIPTION	MATERIAL	UNIT	SCALE	PROJEC'TN	DATE	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	KIM HAE WOOK	MM									
CHKD BY	LEE SANG HAK	NONE									
CHKD BY	KIM KI JOONG	3 mm (3rd Angle)									
DSND BY	CHOI YOUNG SIN	2003.07.18									
AVR CONNECTION DIAGRAM											
TITLE											
SUBJECT											
HFC7 45-56.FR											
CONN-DIA/30052140											
REF. NO											
DWG NO											
3G-002029											
Revision No.											
0											
Sheet No. of											
0											
CONTENTS											
REV											
DATE											
50S											
12.5S											
3.2S											
0.4S											

* SEE NOTE 1
FIELD FLASHING CIRCUITRY



HYUNDAI
HEAVY INDUSTRIES CO., LTD.
INDUSTRIAL & POWER SYSTEMS



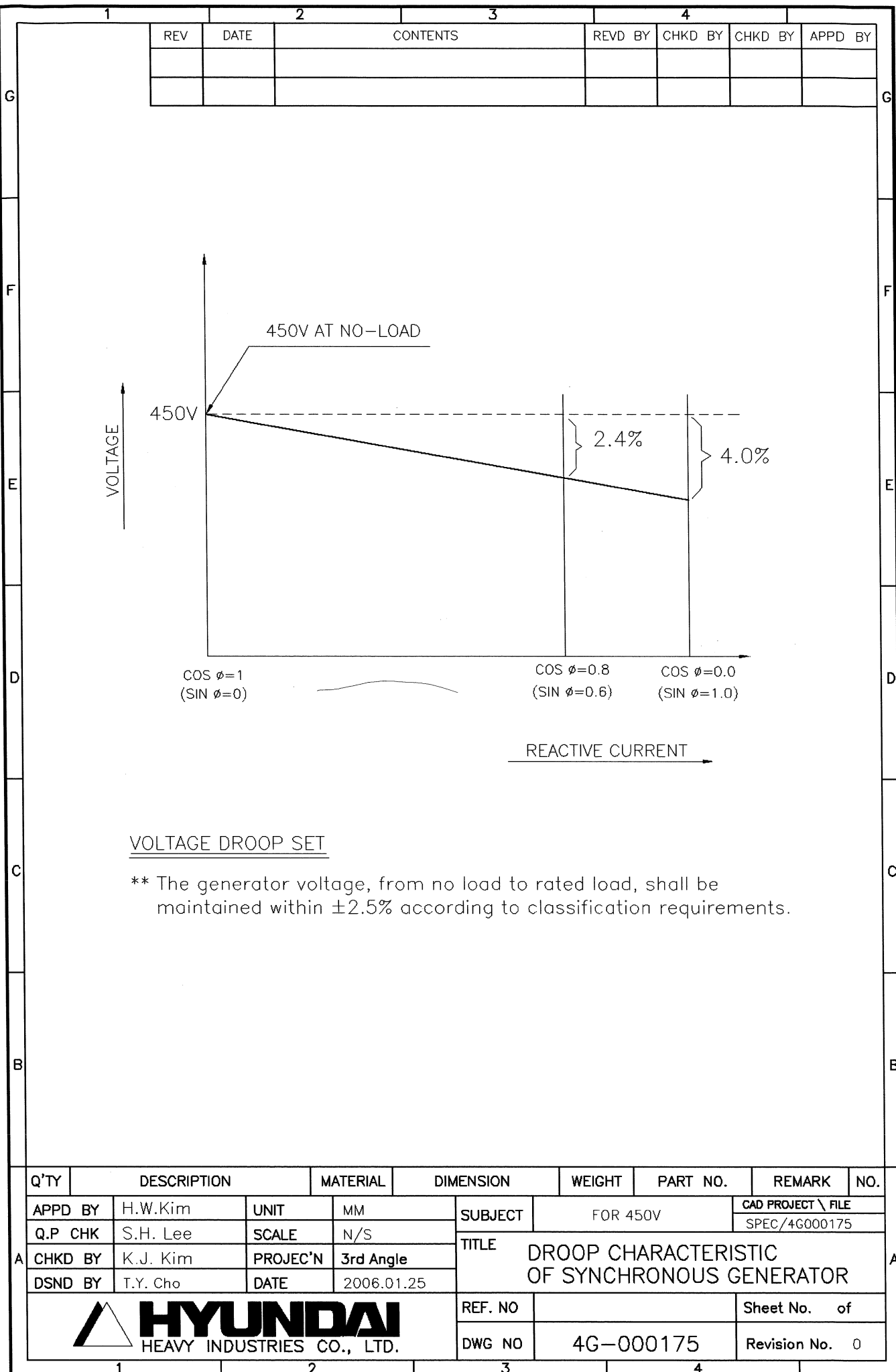
WITH
REFERENCE
VALUE SETTER

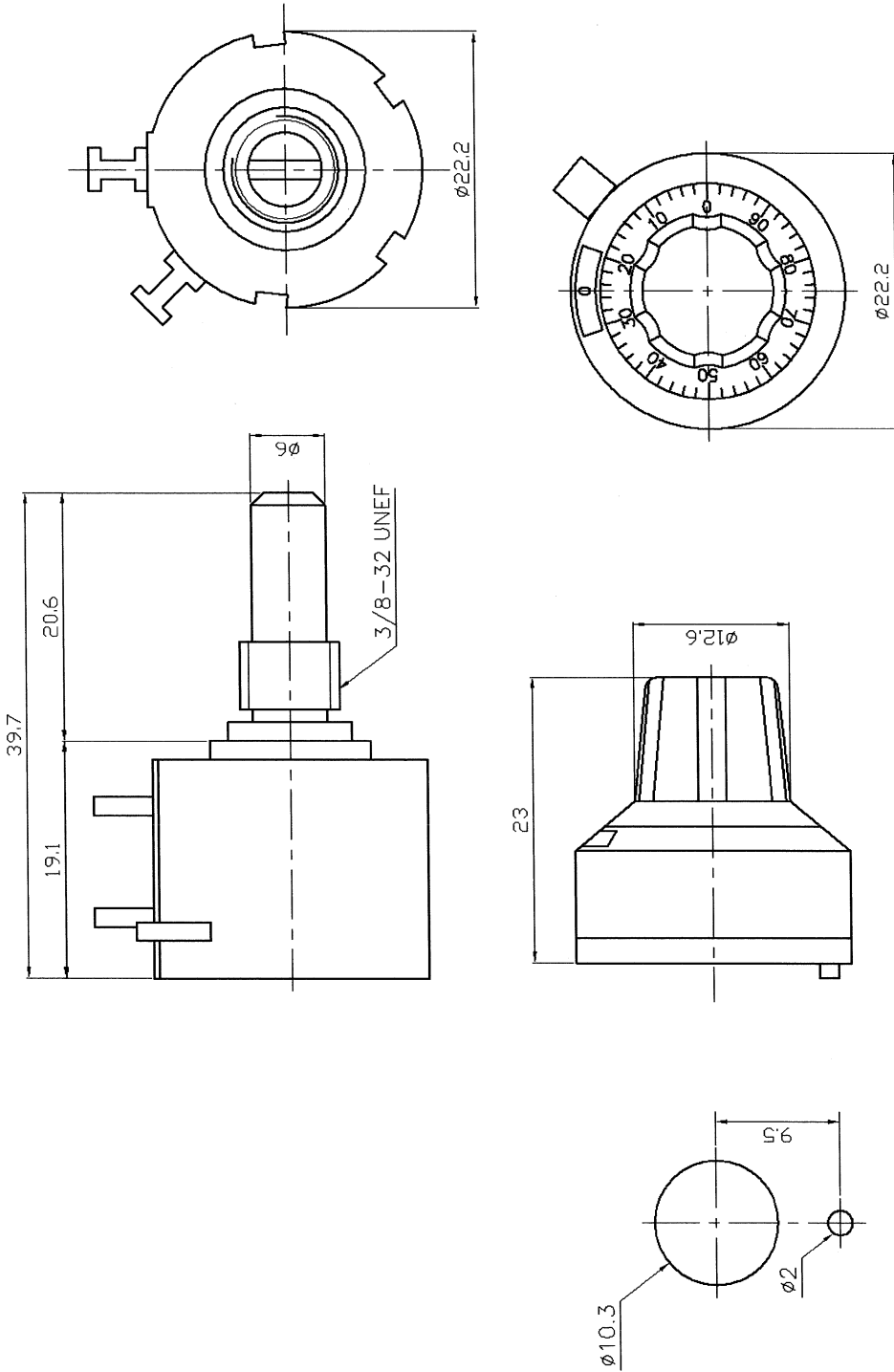
* LEGEND

- 1) B.T.D : BEARING TEMPERATURE DETECTOR
2) W.T.D : WINDING TEMPERATURE DETECTOR
3) N.D.E : NON-DRIVE END SIDE

Q'TY	DESCRIPTION			MATERIAL	DIMENSION		WEIGHT	PART NO.	REMARK	NO.
	APPD BY	H.W.KIM	UNIT		SUBJECT					
	Q.P	CHK	S.H.LEE	N/S			HFC6&7			
	CHKD BY	K.J.KIM	PROJECT N	3 544(3rd Angle)	TITLE					
	DSND BY	S.R.CHOI	DATE	2007.05.07	TERMINAL CONNECTION DIAGRAM					
 HYUNDAI ELECTRICAL ENGINEERING CO., LTD.					REF. NO		Sheet No.	of		
					DWG NO	3G-002055	Revision No.	Δ		

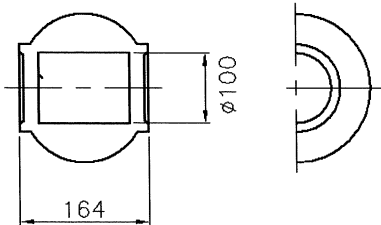
[illegible]





CUTTING HOLE FOR
PANEL MOUNT 'G'

REV	DATE	CONTENTS	REV BY	CHKD BY	APPD BY	REVISION	QTY	DESCRIPTION	UNIT	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
▽	50S														
▽	12.5S														
▽	3.2S														
▽	0.4S														
REFERENCE VALUE SETTER															
TITLE															
SUBJECT															
5 KOHM, 2W															
ACCY-ATT/3R053674															
CAB PROJ # \ FILE #															
REVISION															
3M-053674															
DWG NO															
Sheet No. of															
Revision No. 0															
2002.12.03															
DATE															
KIM KI JUNG															
CHKD BY															
3 mm (3rd Angle)															
SCALE															
N/S															
MM															
H.W. KIM															
APPD BY															
H.W. KIM															
QTY															

SPARE PART FOR A.C GENERATOR			DWG. NO.	4M-023970		1/1
ITEM NO.	NAME OF PARTS	OUTLINE	QUANTITY			REMARK
			WORKING		SPARE	
			SET	PER VESSEL		
1	BEARING SHELL		1	3	1	PH100XL120 (SELF LUB)

BRG-AS02\4r023970

1	2	3	4
▽	50S	REV	DATE
▽▽	12.5S	△	2008.08.11
▽▽▽	3.2S		
▽▽▽▽	0.4S		

A. LOCATION OF TERMINAL BOX : ALL RIGHT SIDE △

(VIEWED FROM ENGINE SIDE)

B. CABLE ENTRY (TOP or BOTTOM) : ALL TOP SIDE △

△

△

ENGINE
VIEWED FROM ENG. SIDE

NO.3
GENERATOR

TERMINAL BOX
RIGHT SIDE

ENGINE
VIEWED FROM ENG. SIDE

NO.2
GENERATOR

TERMINAL BOX
RIGHT SIDE

ENGINE
VIEWED FROM ENG. SIDE

NO.1
GENERATOR

TERMINAL BOX
RIGHT SIDE

Q'TY	DESCRIPTION	MATERIAL	DIMENSION	WEIGHT	PART NO.	REMARK	NO.
APPD BY	D. S. KIM	UNIT	MM	SUBJECT		CAD PROJ # \ FILE #	
CHKD BY	S. H. LEE	SCALE	NS	TITLE		/G-ASS'Y/4R057762	
DSND BY	S. J. LEE	PROJEC'N	3 각법(3rd Angle)	D/G SET PLAN VIEW			
TRCD BY	KIM JOO HYONG	DATE	2000.06.13				
HYUNDAI ELECTRICAL ENGINEERING CO., LTD.				REF. NO	Sheet No. of		
				DWG NO	4M-057762		